Trinity Alps Wilderness Prescribed Fire Project

Fire, Fuels, Air Quality and Vegetation Report

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Introduction

The effects of past management coupled with a warming climate compromise the project area landscape's ability to meet desired conditions within the Trinity Alps Wilderness as specified in the Shasta-Trinity National Forest Land and Resource Management Plan. The need for action in the project area evolved primarily from changes in fire regimes over the last century. Therefore, the Shasta-Trinity National Forest is proposing prescribed burning within the Trinity Alps Wilderness.

The purpose of the project is to:

1. Reduce the risks and consequences of wildfire occurring within the wilderness or escaping from the wilderness (i.e., reduce fuel accumulations in the project area).
2. Create a fuels condition that enables the use of Minimum Impact Suppression Tactics that make use of natural barriers, topography or watercourses.
3. Permit future lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness (i.e., trend the project area toward historic fire regime conditions).
4. Reduce the risks and consequences of public health and safety concerns created by hazardous air conditions during future wildfire events.

This report analyzes the effects of the proposed Trinity Alps Wilderness Prescribed Fire Project on fire, fuels, air quality and vegetation.

Proposed Action and Alternative 3

Approximately 16,709 acres are proposed for treatment under Alternative 2 as part of the Trinity Alps Wilderness Prescribed Fire Project. Prescribed fire treatments would meet desired conditions by increasing the landscape's resilience to severe wildfire, restoring fire to the ecosystem, and decreasing surface and ladder fuels in strategic locations - such as major ridgelines - to help reduce fire risks and consequences. Implementation of the proposed action would likely occur over a period of approximately six to ten years.

Proposed treatments consist of utilizing prescribed fire to create a mosaic-pattern of burn severities, primarily of low- to moderate-intensity surface fire. Prescribed fire lighting techniques would consist of aerial ignition (plastic sphere dispenser and/or helitorch), primarily along ridge tops, and/or hand lighting methods. All phases of implementation would follow Minimum Impact Suppression Tactics[1] (MIST) and Forest Service Manual (FSM) 2324.23 direction for fire management activities in wilderness. In accordance with these two guides, the Forest Service would employ methods that result in the least amount of disturbance, or alteration of wilderness characteristics; and that can be used safely and effectively to implement the proposed action.

The timing of implementation would be determined based on current and predicted weather conditions, fuels conditions and compliance with State and federal air quality

[1] NWCG 2003

standards, with the intent to create primarily low- to moderate-intensity surface fires that would trend the project area toward the desired condition.

Alternative 3 was developed to respond to concerns by fire and fuels specialists over fuels conditions within the Virgin Creek drainage and includes all of the treatments under the proposed action (see above), as well as an additional 2,379 acres. Total treatments of approximately 19,088 acres of prescribed fire would occur under this alternative.

See Chapter 2 of the Environmental Assessment (EA) for detailed descriptions and maps of alternatives including the No Action Alternative.

Regulatory Framework

Policy, Laws and Direction

The following current laws, policy and direction to fire/fuels, vegetation and air quality apply to the Trinity Alps Wilderness Prescribed Fire Project:

- Shasta-Trinity National Forest Land and Resource Management Plan and Record of Decision (April 28, 1995)
- Northwest Forest Plan Record of Decision (April 13, 1994)
- Managing the Impacts of Wildfires on Communities and the Environment (The National Fire Plan) (September 8, 2000)
- A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Strategy Implementation Plan (December 2006)
- Forest Service Manual 5100 (Wildland Fire Management)
- Forest Service Manual 2000 (National Forest Resource Management, Chapter 70 Vegetation Ecology)
- Forest Service Manual 2300 (Recreation, Wilderness, and Related Resource Management, Chapter 2320- Wilderness Management)
- California Wilderness Act of 1984 (Public Law 98-425)
- Wilderness Act of 1964 (Public Law 88-577 [16 U.S. C. 1131-1136])
- Clean Air Act of 1977 (Public Law 91-604 [42 U.S. C. 7401-7626])
- National Environmental Policy Act of 1969 (Public Law 94-52 [42 U.S. C. 4321-4347])
- California Code of Regulations Title 17, Subchapter 2, Smoke Management Guidelines for Agriculture and Prescribed Burning

Land and Resource Management Plan

The LRMP provides four integrated levels of direction: (1) Forest-wide direction, (2) Land Allocations and Standards and Guidelines from the ROD, (3) Management Prescription Direction and (4) Management Area Direction[2].

Forest Wide Direction

Forest-wide direction includes: (1) Forest goals, (2) Forest objectives, including Forest-wide prescription assignment by acres, outputs and activities, and (3) Forest Standards and Guidelines. Forest goals state the management philosophy of the Forest Plan. Forest-wide prescription assignments allocate acreage to Management Prescriptions. Estimated outputs and activities quantify Forest-wide resource outputs and costs by decade. Forest Standards and Guidelines provide basic direction for implementation of management activities Forest-wide. Standards are not explicitly distinguished from guidelines; the language of each statement shows the degree, if any, of management discretion. They apply Forest-wide.

Forest Goals

Fire and Fuels

- Restore fire to its natural role in the ecosystem when establishing the Desired Future Condition of the landscape.[3]
- Achieve a balance of fire suppression capability and fuels management investments that are cost effective and able to meet ecosystem objectives and protection responsibilities.[4]

Air Quality

- Maintain air quality to meet or exceed applicable standards and regulations.[5]

Vegetation

- Integrate multiple resource management on a landscape level to provide and maintain diversity and quality of habitats that support viable populations of plants, fish, and wildlife.[6]
- Implement practices designed to maintain or improve the health and vigor of timber stands, consistent with the ecosystem needs of other resources.[7]

Standards and Guides

Forest–Wide Standards and Guides

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[2] LRMP p. 4-1
[3] Ibid.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] LRMP p. 4-5

Fire and Fuels

- Wildland fires will receive an appropriate suppression response that may range from confinement to control. Unless a different suppression response is authorized in this Plan, or subsequent approved Plans, all suppression responses will have an objective of "control."[8]
- Plan and implement fuel treatments emphasizing those treatments that will replicate fire's natural role in the ecosystems.[9]
- Natural fuels will be treated in the following order of priority: (1) public safety; (2) high investment situations (structural improvements, powerlines, plantations, etc.); (3) known high fire occurrence areas; and (4) coordinated resource benefits, i.e., ecosystem maintenance for natural fire regimes[10].
- Consider fuelbreak construction investments when they compliment Forest health/biomass reduction needs, very high and extensive resource values are at risk and to protect Forest communities[11].

Air Quality

- Protect air quality while achieving land and resource management goals and objectives. Base line levels will be established, and available technology will be used to predict and monitor changes. Activities such as burning, which are under Forest's control, will be coordinated with affected landowners and control agencies.[12]
- Establish and maintain close coordination with Federal, State, and local officials in the research and application of new air quality standards particularly in relation to smoke and dust.[13]
- Incorporate smoke management controls into the development of prescribed burn plans, and coordinate with local authorities.[14]

Vegetation

- Manage vegetation to retain the primeval character of the wilderness environment and to allow natural ecological processes to operate freely. Remove trees only under emergency conditions such as fire, or insect and disease control.[15]

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[8] LRMP p. 4-17
[9] LRMP p. 4-18
[10] Ibid.
[11] Ibid.
[12] LRMP p. 4-13
[13] Ibid.
[14] LRMP p. 4-14
[15] LRMP p. 4-29

Management Prescription Direction- Congressionally Reserved Areas

Fire and Fuels

- Prepare Fire Management Action Plans that will consider and define the circumstances to use in confine, contain, and control suppression strategies.[16]
- Locate incident bases and staging areas outside of Wilderness. When necessary within a Wilderness, use small (50-60 people) suppression camps in areas where degradation of water quality can be avoided. Return sites to pre-use condition.[17]
- Use of prescribed fire from planned ignitions to perpetuate natural ecosystems, or to protect adjacent resources, may be undertaken only after Washington Office approval[18]
- Permit helispots when approved by the Forest Supervisor. Use natural openings to the extent possible.[19]

Air Quality

There is no management prescription direction for air quality in the LRMP.

Vegetation

- Maintain snags and hardwoods at naturally occurring levels...[20]

Management Area Direction

Trinity Alps Wilderness

- Fire management is prescriptive, allowing wildfire to perform its ecological function within defined parameters[21].
- Develop a fire management plan, which uses planned and unplanned ignition to restore and maintain natural conditions. When implementing this plan, maintaining air quality is an overriding consideration.[22]

Forest Service Manual Direction

Forest Service Manual (FSM) 2300

Forest Service Manual (FSM) 2300, Chapter 2320 Wilderness Management[23] defines the agency policy for management of resources in federally designated wilderness areas. Policy and direction therein that applies to the action alternatives includes the following:

2323.5 Management of Forest Cover

[16] LRMP p. 4-33
[17] Ibid.
[18] Ibid.
[19] LRMP p. 4-34
[20] LRMP p. 4-34
[21] LRMP p. 4-94
[22] LRMP p. 4-95
[23] USDA Forest Service 2007

2323.51-Objective

Manage forest cover to retain the primeval character of the environment and to allow natural ecological processes to operate freely.

2323.52-Policy

1. Permit ecological processes to operate naturally.
2. Recognize both climax and successional biotic communities as natural and desirable.
3. Allow, whenever possible, the natural process of healing in handling disturbed communities. Consider structural or vegetative assistance only as a last resort.
4. Only allow vegetation to be cut or sold when necessary for wilderness purposes or on valid mining claims under specified conditions, or when emergency conditions like fire, insects and disease, or protecting public safety make it necessary.

2323.6 Management of Air Resource

2323.61 Objectives

1. Protect air quality and related values, including visibility, on wilderness land designated class I by the Clean Air Act as amended in 1977 (FSM 2120).
2. Protect air quality in wilderness areas not qualifying as class I under the same objectives as those for other National Forest System lands (FSM 2120).

2323.62 Policy

1. Define air quality related values (AQRV) and initiate action to protect those values.
2. For each air quality related value, select sensitive indicators, monitor and establish the acceptable level of protection needed to prevent adverse impacts (FSM 2120).
3. Determine the potential impacts of proposed facilities in coordination with State air quality management agencies. Make appropriate recommendations in the permitting process following established Prevention of Significant Deterioration application review procedures for major emission sources. Request to air quality management agencies for consideration of class II values in the permit process are appropriate (FSM 2120).
4. Manage smoke from management ignited prescribed fires occurring in or adjacent to class I wilderness areas in a manner that causes the least impact on air quality related values (FSM 2324).

2324.2 Management of Fire

2324.21 Objectives

The objectives of fire management in wilderness are to

1. Permit lighting caused fires to play, as nearly as possible, their natural ecological role within wilderness.
2. Reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness.

2324.22 Policy

1. Two types of prescribed fires may be approved for use within wilderness: those ignited by lightning and allowed to burn under prescribed conditions and those ignited by qualified Forest Service officers.
2. No fire may be ignited or allowed to burn without documented, preplanned, specified conditions.
3. Document specific objectives, standards, and guidelines for the control of wildfire and the use of prescribed fire within each wilderness (FSM 5100, 5150, and 5190) in a forest plan or, where the forest planning process has not been completed, in either an interim wilderness management or fire management area plan. Document specific directions for fire program implementation in the forest fire management action plan (FSH 5109.19).
4. Suppress all wildfires within wilderness in accordance with the direction in FSM 5130.
5. Fire ignited by lightning may be permitted to burn if prescribed in an approved plan 2324 and 5150.
6. Forest Service managers may ignite a prescribed fire in wilderness to reduce unnatural buildups of fuels only if necessary to meet at least one of the wilderness fire management objectives set forth in FSM 2324.21 and if all of the following conditions are met:
    a. The use of prescribed fire or other fuel treatment measures outside of wilderness is not sufficient to achieve fire management objectives within wilderness.
    b. An interdisciplinary team of resource specialists has evaluated and recommended the proposed us of prescribed fire.
    c. The interested public has been involved appropriately in the decision.
    d. Lightning-caused fires cannot be allowed to burn because they will pose serious threats to life and/or property within the wilderness to life, property, or natural resources outside of wilderness.
7. Do not use prescribed fire in wilderness to benefit wildlife, maintain vegetative types, improve forage production or enhance other resource values. Although these additional effects may result from a decision to use prescribed fire, use fire in wilderness only to meet wilderness fire management objectives.
8. Do not use management of ignited fire to achieve wilderness fire management objectives where lightning caused fires can achieve them.

Minimum Impact Fire Management Activities

In the Alps, the Forest promotes minimum impact suppression methods that make use of natural barriers, topography or watercourses. Forest Service Manual (FSM) 2324.23 - Fire Management Activities[24] directs the Forest Service to

> *Conduct all fire management activities within wilderness in a manner compatible with overall wilderness management objectives. Give preference to using methods and equipment that cause the least:*

[24] USDA Forest Service 2007

- *Alteration of the wilderness landscape.*
- *Disturbance of the land surface.*
- *Disturbance to visitor solitude.*
- *Reduction of visibility during periods of visitor use.*
- *Adverse effect on other air quality related values.*
- *Locate fire camps, helispots, and other temporary facilities or improvements outside of the wilderness boundary whenever feasible. Rehabilitate disturbed areas within wilderness to as natural an appearance as possible.*

In addition, the National Wildfire Coordinating Group has implemented a strategy of Minimum Impact Suppression Tactics (MIST), with guidelines for managing fires with the least impact to values at risk[25]. These guidelines for suppressing wildfires are also applied to prescribed fires.

Watershed Analysis Key Findings and Recommendations

The New River Watershed Analysis[26] (WA) encompasses the project area. The WA recommends reducing fire hazard, working in conjunction with and protecting communities and risk, protecting resource values, and using fuel treatments to reduce adverse impacts to air quality. See Chapter 1 of the EA for more detailed information.

Fire and Fuels

Issues and Issue Indicators

Issues relating to fire and fuels are stated below, which were identified by the project fuels specialist and from comments received during the scoping period. The methodologies for measuring the issue indicators are described in detail here.

Issue: Project activities may cause unplanned or adverse fire behavior and intensity.

Major concerns within the project boundary are the potential fire effects to resources (e.g., wildlife habitat, soils, human uses/recreation, hydrology, air quality, etc.), public and firefighter safety and fire escaping the wilderness into nearby communities at risk. The following issue indicators were identified to address these concerns.

Issue Indicators:

- Crown fire potential – a measurement indicator of whether a fire is likely to stay on the surface or move through the crowns given a set of stand and burning conditions.
- Flame length potential – a visual and measurement indicator of surface fire intensity. Flame length is a measure of the distance along the slant of the flame from the midpoint of its base to the tip.

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[25] NWCG 2003
[26] USDA Forest Service 2000

Analysis Methodology

Methodology for Existing Condition

FlamMap was used to model fire behavior for existing conditions. FlamMap is a fire behavior mapping and analysis program that computes fire behavior characteristics over a landscape of constant inputs of weather and fuel moisture conditions[27]. The results consist of crown fire and flame length potential. All fire model runs were calculated using the California Fuels Landscape data set, which uses vegetation data to obtain fuel models.

Weather and fuel moisture conditions were calculated for three scenarios, all obtained by a climatology program (FireFamilyPlus) that collects historical weather data for analysis. The scenarios were used to evaluate moderate to extreme weather conditions that have been experienced within the analysis area in the past.

The first scenario calculated fire behavior under 90th percentile weather conditions or severe weather conditions. Fires under 90th percentile weather conditions have demonstrated significant fire growth and fire effects in the past. Fuel moistures under such conditions are very dry.

The second scenario calculated fire behavior under 52nd percentile weather conditions or moderate weather conditions. On the Shasta Trinity National Forest, this is typically when fire growth occurs or when fire suppression concerns arise. Fuel moistures under such conditions are dry.

The third scenario calculated was fire behavior conditions under increased wind, to show potential fire behavior and effects under extreme weather conditions. This scenario looked at past wildfires and fire weather (i.e., the Megram Fire/Big Bar Complex of 1999 and the Bake-Oven Fires of 2006) to mimic a similar situation in and around the analysis area.

For the analysis of existing conditions, only 90th percentile conditions are displayed. These conditions serve as somewhat of an overall average of the three conditions mentioned. In addition, areas of concern did not change over the three scenarios, but were less or more prominent depending on weather and fuel moisture inputs. The results of these runs also contributed to treatment design.

Fieldwork occurred at various times throughout the planning of this project. In 2010, five days were spent on the ground near Salmon Summit and along the trail system between the Shasta-Trinity, Six Rivers and Klamath National Forests, and Denny, California. The work consisted of taking photos, assessing fuel loadings and vegetation types.

In the fall of 2013, four days were spent in the project area. During that time the fieldwork consisted of verifying fuel loadings, implementation units and past suppression features (helispots, control lines, etc.). Additionally, information/data was collected from past wildfires that occurred in the project area which was used in project design, specialist reports and treatment parameters.

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[27] Finney 1998

Fire Regime and Historic Reference Conditions (Condition Class)

A natural fire regime is a general classification of how fire played a role in an ecosystem, in the absence of modern human intervention but including the influence of aboriginal burning[28] [29]. Coarse-scale definitions of fire regimes are defined in separate research studies by Hardy[30] and Schmidt[31] and interpreted for management of fire and fuels by Hann and Bunnell[32]. The five natural (historical) fire regimes as described by historical fire frequency (average number of years between fires) and historical fire severity (the effect of the fire on dominant overstory species) are described in table 1 below.

Table 1. Descriptions of historic natural fire regimes

Historical Natural Fire Regimes	
Code	**Description**
I	0–35-year frequency [a], low and mixed severity [b]
II	0–35-year frequency, stand-replacement severity
III	35–100+ year frequency, low and mixed severity
IV	35–100+ year frequency, stand-replacement severity
V	200+ year frequency, stand-replacement severity
a. Fire frequency is the average number of years between fires. b. Severity is the effect of the fire on the dominant overstory vegetation.	

Historical (pre-suppression) fire return intervals were compared to contemporary (suppression-era) fire return intervals over the project area. This analysis is known as condition class based on departure from fire return interval. The mean historic fire return interval ranged from approximately 10 years to 60 years depending on biophysical setting. A biophysical setting is defined as a combination of vegetation and topographic, soil, and climate variables that influence vegetation development.

The following equation determines departure of fire return intervals:

$\{1 – (\text{Reference FRI}/\text{Current FRI})\} * 100$

The value obtained is a percent difference, and condition class is determined using the LANDFIRE national scale (i.e., 0-33 percent departure = condition class 1; 33-67 percent

[28] Agee 1993
[29] Brown 1995
[30] Hardy et al. 2001
[31] Schmidt et al. 2002
[32] Hann and Bunnell 2001

departure = condition class 2; and greater than 67 percent departure = condition class 3[33]). Other assumptions come from Safford and Schmidt[34].

Methodology for Effects Analysis

The cumulative effects analysis area for fire, fuels and vegetation is the project area. This includes approximately 58,349 acres. The cumulative effects analysis shows the effects of action and no action alternatives within the project area. The direct and indirect effects would occur as the proposed treatments within the project boundary are implemented over approximately six to 10 years. The cumulative effects analysis period is 20 years from completion of project activities. If the No Action alternative were selected then the period would be 20 years from the date of the decision. Beyond this time, the effectiveness of fuels treatments would diminish with the continued suppression of fires within the wilderness.

The cumulative effects analysis considers the project area as the furthest extent of effects in the modeling of all alternatives. The project area was chosen as the analysis area because this provides the most comprehensive display of effects to fire and fuels from implementation of the alternatives. While the alternatives may change the risk of future fires entering or leaving the project area, the alternatives would not be expected to affect fire behavior outside the project area.

Fuels, weather and topography influence how a fire will burn. The hazard associated with weather and topography cannot be changed; however, fuel loading, vegetation structure and vegetation composition can be modified to influence fire behavior and fire effects to post-fire vegetation conditions. The action alternatives focus on sustaining diverse, fire-resilient ecosystems and propose only prescribed fire to modify fuel loading, vegetation structure and composition.

Flame length and fire type (see Flame Length and Crown Fire Potential sections below) were used as indicators to measure the effects of alternatives on fire hazard and resistance to control. A comparison of indicators using ArcFuels was completed for all alternatives. ArcFuels is an ArcGIS interface that links fire behavior models and spatial analysis for fuel treatment planning.

For this analysis, ArcFuels linked fire behavior modeling (FlamMap) with fuels and vegetation data. Additionally, MS Excel and ArcGIS was used to interpret the data and produce spatial outputs for analysis allowing for the assessment of varying alternatives and/or treatments to be displayed and readily contrasted. We anticipate that treatments would occur over a six to 10 year period. The years modeled do not necessarily indicate when actual implementation would occur.

Fire behavior modeling uses input variables to calculate fire behavior. The three primary variables affecting fire behavior are fuels, weather and topography. Because fuels are the primary variable that management activity can influence, they were the main variable used in this analysis and were based on 90th percentile weather conditions. See table 2 below.

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[33] LANDFIRE scale and equation were derived from NIFTT, 2010.
[34] Safford and Schmidt, 2006

Table 2. Modeling inputs based on weather conditions under 90th percentile conditions*

Parameter	90th Percentile Weather Output
Woody Fuel Moisture	70 percent
Herbaceous Fuel Moisture	30 percent
1000 Hour Fuel Moisture	10 percent
100 Hour Fuel Moisture	5 percent
10 Hour Fuel Moisture	3 percent
1 Hour Fuel Moisture	3 percent
Wind Speed	6 miles per hour

*90th percentile weather conditions were based on the Energy Release Component. Remote Automated Weather Stations (RAWS) used for analysis included Backbone, Big Bar, Blue Ridge, Scorpion and Friend Mountain.

Flame Length Potential

One of the primary metrics used for assessing fire hazard or fire behavior is flame length. Flame length is an indicator of how hot or severe a fire can become and the level of difficulty fire managers will have in controlling a fire. Fireline intensity (measured in BTUs/sq. ft.) provides a second correlation to resistance to control and potential fire effects (see project file). These metrics provide a means for assessing the potential for fires becoming difficult to suppress or contain, the potential to threaten communities at risk and the potential to threaten resource values (e.g. wildlife habitat, soil stability, human uses, hydrology and air quality). See table 3 below.

Table 3. Flame length potential and fireline intensity used for analysis of issue indicators.

Flame Length (ft.)	Fireline Intensity (BTUs/ft.)	Description
0'	0	*Very Low* – Non-flammable areas such as rock outcropping, water, etc.
0-4'	0 – 1200	*Low* – Persons using hand tools can generally attack fires at the head or flanks of the fire.
4-8'	1201-2200	*Moderate* – Fires are too intense for direct attack on the head of the fire by persons using hand tools. Equipment such as dozers, engines and retardant aircraft can be effective.
8-12'	2201+	*High* – Fires may present serious control problems such as torching, crowning, and spotting. Control efforts at the head of the fire will probably be ineffective.
Greater than 12'	2200+	*Very High* – Fires present serious control problems and suppression efforts are typically ineffective.

Crown Fire Potential

Another hazard parameter is fire type, which includes crown fire. Crown fire potential is a measure of whether a fire is likely to stay on the surface or move through the crowns given a set of stand and burning conditions. This measure is useful for analyzing the risk of losing a forested overstory to wildfire. Extensive crown fires can especially be an issue in vegetation types that are not adapted to respond to high-intensity crown fires. The following categories define fire type:

Surface fire – The fire remains on the forest floor. The combination of surface fire intensity and ladder fuels is not sufficient to move a fire into the crowns under the defined burning conditions.

Passive crown fire – Individual tree or group torching occurs. The combination of surface fire intensity and ladder fuels allows for movement into the crowns under the defined burning conditions, but canopy bulk density is too low for fire to spread through the crowns under the projected wind speeds.

Active crown fire – The combination of surface fire intensity, ladder fuels and canopy bulk density allows fire to move into, and spread through, the crowns under the defined burning conditions.

Existing Condition

Fire History in the Trinity Alps Wilderness

Few forested regions have historically experienced fires as frequently and with such high variability in fire severity as the Klamath Mountains Bioregion[35]; this is primarily due to climatic variables and the diverse physical and biotic arrangement of the Klamath Mountains. South- and west-facing aspects and upper slope positions typically experienced higher severity fire than lower slopes and north- and east-facing aspects. On the western edge of the Klamath Mountains, median fire return intervals ranged from 15 to 26 years[36] and lower elevation mixed conifer forests burned every 5 to 19 years[37] [38]. With frequent fire of low to mixed-severity, fuel accumulations over most of the area were historically maintained at low levels, and landscape features such as ridge-tops and streams were often sufficient to impede fire spread[39].

Fire suppression efforts were institutionalized after the establishment of the National Forest System. Since the onset of fire suppression in the early 1900s, and with the increased effectiveness of mechanized suppression techniques (fire engines, aircraft, etc.) in later years, most of the fires were kept small until recent years. Figure 1 on the following page shows the amount of acres burned by decade within the Trinity Alps Wilderness from 1917 to 2017.

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[35] Taylor and Skinner 1998
[36] Stuart and Salazar 2000
[37] Fry and Stephens 2006
[38] Taylor and Skinner 2003
[39] Ibid.

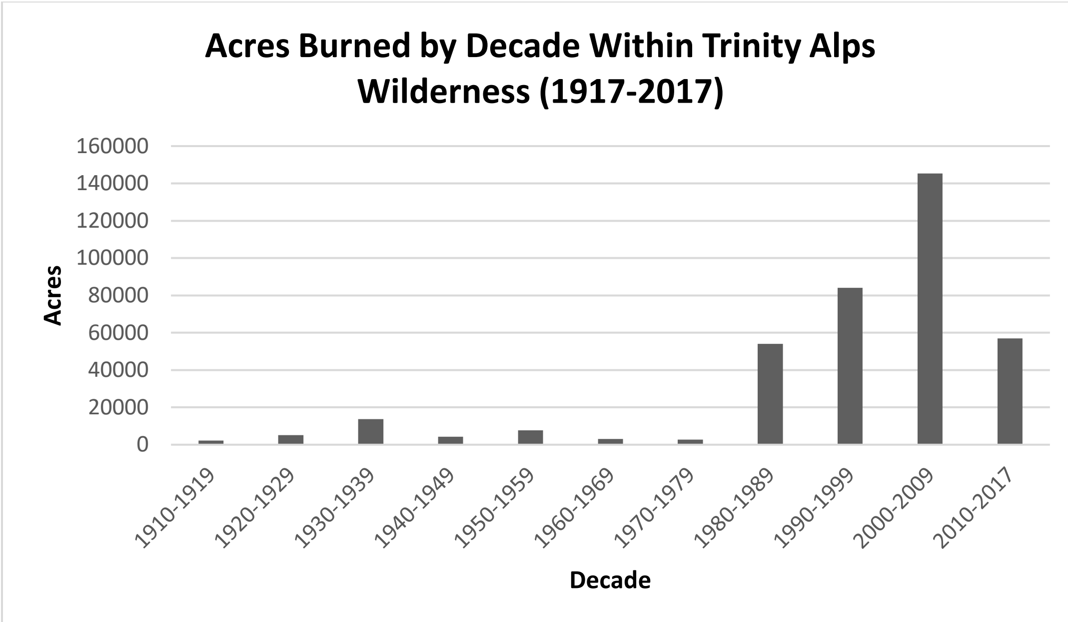

Figure 1. Acres burned in the Trinity Alps Wilderness from 1917 to 2017

With successful fire suppression, fuels and vegetation density have increased and fires have become more intense and difficult to control, especially in the western half of the Trinity Alps. Examples of fires burning, at least in part, within the wilderness are described below. Vegetation-based fire severity helps describe fire effects (data only available after 1984) on the landscape and was used to assess portions of fires that burned within the Trinity Alps Wilderness.

In 1977, the Hog fire burned approximately 46,000 acres. Past reports noted that the Hog fire was primarily of high severity, especially in the upper third of the watershed (i.e., Nordheimer and Knownothing creeks). One of the main concerns in post-fire evaluation was over the amount of high severity fire in decomposed granitic soil types that led to heavy amounts of sedimentation in anadromous fish-bearing streams[40].

In 1987, nine fires combined to burn approximately 35,000 acres within the Trinity Alps Wilderness. A widespread lightning event created numerous fire starts over Washington, Oregon and California in which many of the fires burned for months and covered very large areas. With so many fires burning near and within the wildland urban interface (WUI) in the Pacific Northwest, remote and rugged wilderness areas such as the Trinity Alps were of lower priority for the limited fire suppression resources that were available. Persistent temperature inversions during times of atmospheric stability trapped smoke over large areas and created public health and safety concerns due to the hazardous air conditions. High severity fire effects in the Trinity Alps Wilderness during 1987 were primarily on south- and west-facing aspects and upper slope positions. Vegetation-based fire severity from the combined 1987 fires is displayed in table 4 below.

[40] Jimerson and Jones 2003

Table 4. Vegetation fire severity, by severity class, within the Trinity Alps Wilderness in 1987

Severity Class	Acres	Percent Area
Unchanged	4,975	14%
Low	14,430	41%
Moderate	7,839	22%
High	8,008	23%
Total (Portion of fire in wilderness only)	35,252	100%

On August 23, 1999, four separate lightning fires joined to form the Big Bar complex. This fire burned approximately 140,950 acres of timber and brush in about 91 days and covered most of northern California with heavy smoke. Due to health and safety concerns related to smoke, evacuation advisories were issued by the local air quality management district to communities such as Hoopa, Denny and Willow Creek. The suppression cost for this complex exceeded $80 million. The wildfires exacerbated concerns over fires escaping the wilderness into nearby communities at risk. At that time, it was the highest severity fire complex in recorded history within the Trinity Alps Wilderness in terms of large patches of high-severity fire over large areas (see table 5 below). These high severity patches occurred primarily over a few days of strong northeast winds and in areas of heavy blowdown occurring from a strong windstorm in the winter of 1995-1996. Approximately 47 percent of high-severity fire was in large (20 inches dbh or larger) conifer-dominated stands. Map 2 in Appendix B displays fire severities during the Big Bar Complex.

Table 5. Vegetation fire severity, by severity class, during the 1999 Big Bar Complex fires

Severity Class	Acres	Percent Area
Unchanged	3,823	5%
Low	23,535	33%
Moderate	26,558	38%
High	16,662	24%
Total (Portion of fire in wilderness only)	70,578	100%

On July 26, 2006, lightning ignited the Bake and Oven fires in the Trinity Alps Wilderness. These fires grew together, merged with the Pigeon fire and quickly spread north into the canyons above the Trinity River. These wildfires were managed as the Bar Complex, which burned for approximately 122 days and 100,000 acres. High fire severity was primarily on south- and west- facing slopes and upper slope positions.

The Bar Complex cost approximately $65 million to manage and affected several communities at risk. While most of the complex burned at low to moderate severity (see table 6 below), air quality standards exceeded the California Air Resources Board thresholds and many communities suffered long durations of hazardous air quality. Within the project area, the majority of high severity fire (approximately 70 percent) occurred in small (10 to 20 inches dbh) conifer- and shrub-dominated vegetation types. Map 3 in Appendix B displays fire severities during the Bar Complex.

Table 6. Vegetation fire severity, by severity class, during the 2006 Bar Complex fires

Severity Class	Acres	Percent Area
Unchanged	11,383	12%
Low	42,898	45%
Moderate	23,775	25%
High	16,540	17%
Total (Portion of fire in wilderness only)	94,596	100%

On June 21, 2008, a series of lightning strikes ignited approximately 35 wildfires within and adjacent to the 2006 Bar Complex. Many of these fires grew together to be managed as the Iron-Alps Complex, which burned over 100,000 acres in approximately two months before reaching full containment. Ten wildland firefighters lost their lives while suppressing these fires. There were mandatory and voluntary evacuation advisories because of the threat to homes and property and air quality standards again exceeded the California Air Resources Board thresholds within several communities at risk. The Bar Complex cost approximately $82 million to manage. Fire effects were similar to those of the 2006-fire season, with mostly high fire severity confined to south- and west-facing aspects and upper slope positions (Table 7). Map 4 in Appendix B displays fire severities during the Iron-Alps Complex.

Table 7. Vegetation fire severity, by severity class, during the 2008 Iron-Alps Complex

Severity Class	Acres	Percent Area
Unchanged	3,228	11%
Low	14,207	47%
Moderate	7,487	25%
High	5,626	18%
Total (Portion of fire in wilderness only)	30,548	100%

These fires and their consequences have led to debate over how wildfires in remote areas should be managed in the future. The debate revolves primarily around concerns over fire effects to resources (e.g., wildlife habitat, soils, human uses/recreation, hydrology, air quality, etc.), public and firefighter safety and fire escaping the wilderness into nearby communities.

The western half of the Trinity Alps has seen more fire since 1987 than any other part of the Trinity Alps Wilderness and perhaps the entire Klamath Mountain Bioregion. Fire suppression and the Big Bar Complex of 1999 created vegetation and fuels conditions within the project area that are conducive to large fire growth and large areas of high fire severity, with the most recent examples of which include the Backbone and Red Spot fires of 2009 (see Map 5 in Appendix B).

Dense brush combined with a high density of snags and large dead and downed woody debris left over from past fires created conditions that made these 2009 fires difficult to control and threatened firefighter safety. Large snags and downed woody debris fuel types produce more smoke and for a longer duration (smoldering effect) than any other fuel type in the area. These fuel types also helped to carry the Backbone and Red Spot fires during a time of high, live-fuel moistures in brush species.

Numerous snags were felled during the construction of indirect firelines, which the fires never actually reached, and fuels mitigations were not implemented after the fire was contained. These firelines now consist of heavy accumulations of large, dead and downed woody debris. Historically, many of these indirect fire lines located on ridgelines were used to stop fires. The ridgelines are important to fire suppression efforts because, given the area's steep topography, often the only viable option for impeding fire growth is at the ridgelines. Current fuels conditions, partially caused by the construction of past firelines, are no longer conducive for suppressing fires at ridgelines and these conditions are, therefore, of concern with regard to fire escaping the wilderness into nearby communities at risk.

The resulting fuel conditions found over vast areas of the project area is largely defined by an increased loading of snags with dead and down woody material on the forest floor. These large woody fuels, described in current fire behavior models, have little influence on fire spread and intensity of the initiating surface fire; however, they contribute to the development of large fires and high fire severity effects by creating higher resistance to control and burnout time.[41]

Recent Fire History within the Project Area

During the summer of 2013, the Corral Complex burned on the Six Rivers and Shasta-Trinity National Forests. Multiple fires that ignited on August 10 grew together to burn approximately 13,098 acres,[42] of which approximately 800 acres burned in the Trinity Alps Wilderness Prescribed Fire project area.[43] The legal land description of the fire perimeter within the project area includes portions of T7N, R7E, Sections 7, 8, 17, 18 and T8N, R7E, Sections 30, 31, 32, Humboldt Base Meridian (see Map 16 in Appendix B).

The portion of the Corral Complex that burned within the project area is located entirely in designated wilderness. The period of time when the Corral Complex affected the project area was consistent with weather parameters that met the 64th percentile for historic climatology. The fire effects stemmed from large diameter fuels burning and

[41] Brown et al. 2003
[42] RAVG GIS
[43] Corral Fire Burned Area Emergency Response (BAER) 2013

resulting in the consumption of nearby fuels. Moderate- to high-severity fire effects correlated to areas where significant fuel loadings of 100-hr and 1000-hr fuels (large diameter fuels) existed. The high intensities caused by the burning of these fuels led to greater effects to soils and vegetation where these concentrations occurred.

Table 8. Acres burned in the Corral Complex within the project area by severity class.

Severity Class	Grid Code	Within Project Area (acres)	Within Proposed Treatment Area (acres)
Unchanged	1	549	93
Low	2	150	22
Moderate	3	57	5
High	4	44	5
Total		800	125

Although portions of the Corral Complex outside the project area burned at moderate to high intensities over large contiguous areas, the fires had little effect on the project area (Table 8). The current fuel and vegetation conditions within the project area following the Corral Complex still present a risk of wildfires escaping from the wilderness onto adjacent lands and the potential for uncharacteristic fire behavior due to high fuel concentrations.

The portion of proposed treatment areas that burned during the Corral Complex were approximately 125 acres in the 'Salmon Summit to Fawn Ridge' area and is common to both Alternatives 2 and 3. The vegetation severity class within this area is mostly "unchanged." There is a small amount (approximately 5 acres) of high severity within the 125 acres. The unchanged classification indicates lower fuel loading and extremely low vegetation severity effects (Table 8).

The River Complex burned on the Six Rivers and Shasta-Trinity National Forests during the summer of 2015. Lightning caused fires that ignited on July 31 grew together to form the complex, burning roughly 77,805 acres. Approximately 6,055 acres burned within the project area, and 2,285 acres burned within actual treatment areas (Table 9) (Map 17, Appendix B).

Table 9. River Complex burned area within the Trinity Alps Wilderness Prescribed Fire Project.

Name	Total Proposed Acres	Total Burned Acres	Total Burned Area
Project Area	58,349	6,055	10%
Treatment Units in Alternative 2	16,709	2,285	14%
Treatment Units in Alternative 3	19,088	2,285	12%

A summary of the River Complex, vegetation burn severity, results in approximately 70% unchanged to low-fire severity effects within the project area (Table 10). Approximately 12% resulted in moderate and 17% in high. Proposed treatment areas that burned during the River Complex were in the 'Salmon Summit to Fawn Ridge' area (120 acres) and 'Fawn Ridge South' area (2,165 acres). The majority of fuel and vegetative conditions following the River Complex still presents a risk of wildfires escaping from the wilderness onto adjacent lands and the potential for uncharacteristic fire behavior due to high fuel concentrations.

Table 10 Vegetation Burn Severity using rdNBR basal area loss 4 within the Trinity Alps Wilderness Prescribed Fire Project.

	Unchanged		Low Severity		Moderate Severity		High Severity	
Name	Acres	%	Acres	%	Acres	%	Acres	%
Project Area	2,938	48	1,333	22	715	12	1,070	17
Treatment Units in Alternative 2	1,034	45	599	26	302	13	350	15
Treatment Units Alternative 3	1,034	45	599	26	302	13	350	15

Physical Environment

The Trinity Alps Wilderness Prescribed Fire Project is located on the Trinity River Management Unit of the Shasta Trinity National Forest on National Forest System lands. The project area is geographically located within the Eagle Creek, Sixmile Creek and Upper New River watersheds (6^{th} field HUC), or the northwestern corner of the Shasta-Trinity National Forest. This project area is approximately 11% of the Trinity Alps Wilderness, or about 58,349 acres. The terrain is steep and rugged, with slopes commonly exceeding 50 percent. Elevation within the project area ranges from approximately 1,500 feet to 6,700 feet.

Fire Environment of Project Area

Climate

The climate of the project area is Mediterranean, characterized by wet, cool winters and dry, warm summers. Mean annual precipitation varies from approximately 70 inches in the upper portions of the watersheds to nearly 40 inches at the lower end. About 90 percent of the precipitation falls between October and April, with snow usually remaining at higher elevations though May or June. Summer thunderstorms are common and can release significant localized rain. These storms can also be dry with conditions that encourage fire ignition and spread from lightning strikes with the summer 2015 being the latest example of this pattern.

Climate Change

Data derived from weather stations from the Western Regional Climate Center were used to analyze climate trends. Weather stations were limited to those with significant (>50 years) historical weather data and determined to represent the larger project area, namely the Weaverville and Big Bar Remote Automated Weather Station (RAWS) observations. Research of climate trends for the broader Western United States was also considered.

Temperature

For the last ~100 to ~150 years, the climate has shown a relatively rapid warming trend that is projected to continue into the near future.[44] Over the last century, mean annual temperature in the Trinity Alps area has risen by about 2 to 6 degrees Fahrenheit. This trend is primarily driven by an increase in mean minimum (i.e., nighttime) temperatures. The result is that the potential for high fire behavior occurs on more days during the year (based on the energy-release-component index and decrease in predicted relative humidities).[45]

Precipitation

There is no apparent long-term trend in average precipitation, with considerable variability from year to year, but it is predicted that there has been a significant decrease in precipitation falling as snow[46]. With increased mean average temperatures, snow is melting at higher rates and increases in summer drought conditions occur at higher rates.

Fire, Fuels and Vegetation in Climate Change

Fire suppression has led to fuel-rich conditions, and most future climate modeling predicts climate conditions that will likely exacerbate these conditions, thus increasing the likelihood of large fire occurrence. Westerling[47] showed that increasing frequencies of large fires (>1000 acres) across the western United States since the 1980s were strongly linked to increasing temperatures and early spring snowmelt.

Rising temperatures, changing precipitation patterns and declining soil moisture trends have shifted the suitable range for many tree species to higher elevations. With higher rainfall to snowfall ratios and higher nighttime minimum temperatures, broadleaf trees (especially oak species) will become an increasingly important component of conifer-dominated forests. Higher temperatures also correlate with longer summer drought conditions that, in turn, increase drought stress on seedlings and increase wildfire risk. Mitigating increased disturbance from high severity wildfires, while promoting species diversity, is the likeliest strategy to enhance ecosystem resilience in the face of climate change[48].

Vegetation

Vegetation in the project area is described in detail in the *Vegetation* section of this report. Fire suppression policies have led to unnaturally dense vegetation conditions that are

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[44] Skinner 2007
[45] Brown et al. 2003
[46] Butz and Safford 2010
[47] Westerling et al. 2006
[48] Skinner 2007

beyond the historic range of natural variability. The current vegetation conditions, combined with large inter-annual to decadal fluctuations of precipitation, are conducive to large-scale disturbances such as wildland fire, and insect or disease outbreaks. In a historic setting the species composition and density-levels would be different from what occurs today[49]. Fire suppression policies in the project area have created denser, multi-storied stands in a landscape that historically had more stands that were open. In the absence of low-intensity fire, that would have generally consumed surface and ladder fuels, both have increased.

Historic Fire Return Intervals

According to Shasta-Trinity National Forest GIS data, approximately thirteen fires of a thousand (1,000) acres or more have occurred in or entered the project area within an 83-year period (1935 to 2018). Over a 38-year period (1980 to 2018), approximately 59 fire starts occurred within the project area.

Historical and current regional dominance types[50] were primarily Doug las-fir, mixed-conifer, red fir and white fir; however, seral stage distributions have changed through time. Historically, approximately 90 percent of the analysis area supported vegetation at or below a fire return interval (FRI) of 20 years (Fire Regime I) based on Fire Return Interval Departure GIS data provided by the Region 5 Ecology Program (Table 11).

Table 11. Historic fire return intervals (FRI) in the project area

Historic FRI (years)	Acres	Percent of Area
≤ 20	52,336	90%
>20 and ≤ 35	3,533	6%
> 35 and ≤ 60	2,203	4%
>60	277	< 1%

The number of fire occurrences on a given portion of the project area was measured by the departure from historic fire return intervals. Figure 2 below depicts condition class by approximate acres of fire return interval departure. Approximately 91 percent of the project area has missed at least three fire intervals, with some areas having missed as many as six intervals.

[49] Show and Kotok 1924
[50] Regional dominance types are fully described beginning on page 41 of this report.

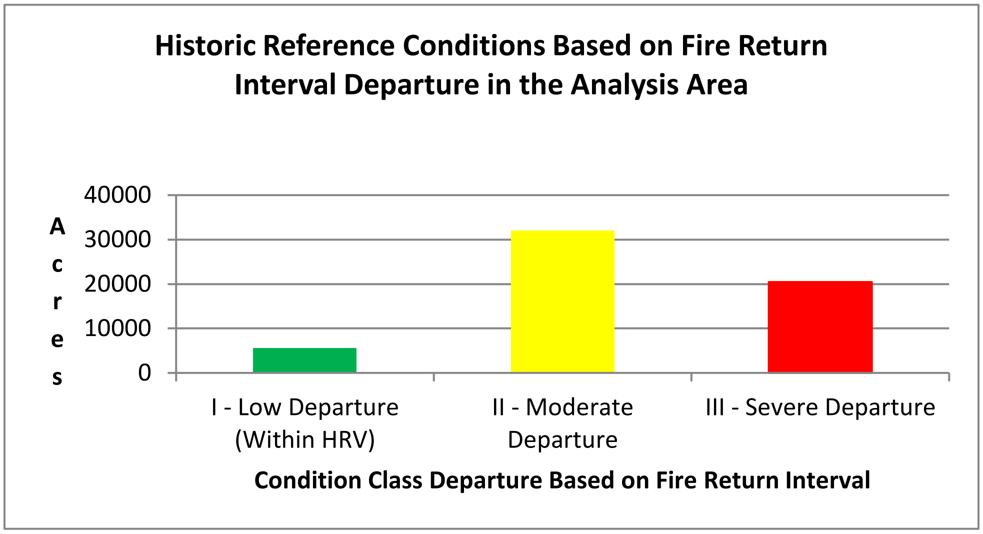

Figure 2. Historic reference conditions (condition class) based on fire return interval departure

Fuels

To model and predict fire behavior, fuels are categorized by fuel models, which are mathematically put into a fire spread calculation.[51] GIS data, supplied by the California Fuels Landscape (i.e., fuel models derived from vegetation data), were obtained to analyze current fuel models[52]within the project area (Table 12).

Table 12. Fuel model descriptions within the analysis area by acres and percentage of area

Fuel Model and Category	Description	Acres of fuel model in project area	Percent within project area
Non-Flammable Fuel Models			
91 97 98 99	Non-Flammable. For example, open water, urban development, or bare ground	138	<1%
Grass-Shrub Fuel Models			
121 GS1	The primary carrier of fire in GS1 is grass and shrubs combined. Shrubs are about 1 foot high, grass load is low. Spread rate is high; flame length moderate.	3,276	6%

[51] Based on Rothermel 1972
[52]Scott and Burgan 2005

Fuel Model and Category	Description	Acres of fuel model in project area	Percent within project area
Shrub Fuel Models			
141 SH1	The primary carrier of fire in SH1 is woody shrubs and shrub litter. Low shrub fuel load, fuelbed depth about 1 foot; some grass may be present. Spread rate is high; flame length moderate.	1,895	3%
142 SH2	The primary carrier of fire in SH2 is woody shrubs and shrub litter. Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate is moderate; flame length moderate.	6,871	12%
145 SH5	The primary carrier of fire in SH5 is woody shrubs and shrub litter. Heavy shrub load, depth 4-6 feet. Spread rate is very high; flame length very high.	5,080	9%
Total percentages of shrub fuel model in project area			**24%**
Timber-Understory Fuel Models			
165 TU5	The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length high.	19,774	34%
Timber-Litter Fuel Models			
182 TL2	The primary carrier of fire in TL2 is broadleaf (hardwood) litter. Low load, compact broadleaf litter. Spread rate is very low; flame length very low.	1,334	2%
183 TL3	The primary carrier of fire in TL3 is moderate load conifer litter, light load of coarse fuels. Spread rate is very low; flame length very low.	5,710	10%
184 TL4	The primary carrier of fire in TL4 is moderate load of fine litter and coarse fuels. Includes small diameter downed logs. Spread rate is low; flame length low.	7,752	13%

Fuel Model and Category	Description	Acres of fuel model in project area	Percent within project area
186 TL6	The primary carrier of fire in TL6 is moderate load broadleaf litter, less compact than TL2. Spread rate is moderate; flame length low.	1,000	2%
188 TL8	The primary carrier of fire in TL8 is moderate load long-needle pine litter, may include small amount of herbaceous load. Spread rate is moderate; flame length low.	1,760	3%
189 TL9	The primary carrier of fire in TL9 is very high load, fluffy broadleaf litter. TL9 can also be used to represent heavy needle-drape. Spread rate is moderate; flame length moderate.	1,806	3%
Total percentages of timber litter fuel models in project area			**33%**
Other Fuel Models			
Other	Other fuel models within the analysis boundary less than 1000 Acres and make up a small percentage of the total area.	1,953	3%
	TOTAL	**58,349**	**100%**
Descriptions based on Anderson, 1982/ Scott, and Burgan, 2005. Fuel models derived from the California Fuels Landscape created by the Region 5 Stewardship and Fireshed Analysis Team and clipped to the analysis area in GIS.			

Fire Behavior- Modeling Outputs

Burn Probabilities under 90th Percentile Conditions

Burn probability defines a pixel (90m x 90m) burning under a specified number of random ignitions (i.e., 5000 fires starts). It provides a method of evaluating a landscape for fuel treatment effectiveness. Burn probability corresponds to how large fires occur on a given landscape and under specified weather conditions. High burn probabilities relate to large fire occurrence. Outputs are described as following:

- Low- 0% - 25%
- Moderate- 26% - 50%
- High- 51% - 75%
- Very High- 76% - 100%

Table 13 and Map 6 (Appendix B) display current burn probabilities in the project area under 90^{th} percentile conditions.

Flame Lengths under 90th Percentile Conditions

Flame lengths serve as a measure of how intense or severe a fire may become and as a proxy for ease of fire suppression to model and predict fire behavior. Flame lengths are described in Appendix B of the Fireline Handbook[53] and are defined as follows:

- Very Low – Non-flammable areas such as rock outcropping, water, etc.
- Low – Flame lengths 0 to 4 feet. Persons using hand tools can generally attack fires at the head or flanks of the fire.
- Moderate – Flame lengths 4 to 8 feet. Fires are too intense for direct attack on the head of the fire by persons using hand tools. Equipment such as dozers, engines, and retardant aircraft can be effective.
- High – Flame lengths 8 to 12 feet. Fires may present serious control problems such as torching, crowning, and spotting. Control efforts at the head of the fire will probably be ineffective.
- Very High – Flame lengths greater than 12 feet. Fires present serious control problems and control efforts are typically ineffective.

Table 13 and Map 7 in Appendix B display predicted flame lengths in the project area under 90^{th} percentile conditions.

Table 13. Current burn probabilities, predicted flame lengths, and crown fire potential within the project area*

Burn probability (acres)	**Very Low**	**Low** (0-25%)	**Moderate** (26%-50%)	**High** (51%-75%)	**Very High** (76%-100%)
	N/A	21,633	22,794	11,040	2,928
Flame Length Potential (acres)	**Very Low**	**Low** (0-4 ft.)	**Moderate** (4-8 ft.)	**High** (8-12ft.)	**Very High** (>12 ft.)
	138	29,752	3,797	3,265	21,443
Crown Fire Potential (acres)	**Non-Burnable**	**Surface Fire (acres)**	**Passive Crown Fire (acres)**	**Active Crown Fire (acres)**	
	138	29,458	26,025	2,774	

* These figures assume a wildfire under 90th percentile weather conditions.

[53] NWCG 2006

Crown Fire Potential under 90th Percentile Condition

Crown fire potential is a measure of how severe a fire may become under specified conditions. Canopy characteristics (e.g., canopy base height, canopy bulk density, stand height, and foliar moisture content), ladder fuels, and fuel loading are all factors that determine crown fire potential. The model assumes uniform canopy characteristics and makes independent fire behavior calculations for each raster landscape (90 m x 90 m cell). Due to these assumptions, the model frequently under-predicts active crown fires[54] [55] [56] [57]. Crown fire measures define the following:

- Surface fire- The fire remains on the forest floor. The combination of surface fire intensity and ladder fuels is not sufficient to move a fire into the crowns under the defined burning conditions.
- Passive Crown Fire- Individual tree or group torching occurs. The combination of surface fire intensity and ladder fuels allows for movement into the crowns under the defined burning conditions, but canopy bulk density is too low for fire to spread through the crowns under the projected wind speeds.
- Active Crown Fire- The combination of surface fire intensity, ladder fuels and canopy bulk density allows fire to move into, and spread through, the crowns under the defined burning conditions.

Table 13 and Map 8 (Appendix B) display current crown fire potential in the project area under 90th percentile conditions.

Fire Risk, Fire Hazard and Values at Risk

The Shasta-Trinity National Forest undertook a re-examination of the integrated vegetation management process in 2009. This process, known as the Integrated Vegetation Management Strategy, characterizes vegetation and its inherent availability to burn in a wildfire. A hazard, risk and value analysis was used for this strategy. Hazard is defined as fire behavior potential, which has implications for resource damage as well as suppression capability. Risk is the likelihood of a fire occurring based on wildfire history. Value refers to the monetary, ecological, or political significance of a defined area.

The policy, law and planning underpinnings of the strategy include but are not limited to the following:

- Shasta-Trinity National Forest Land and Resource Management Plan and Record of Decision (April 28, 1995)
- Northwest Forest Plan Record of Decision (April 13, 1994)

[54] Fule et al. 2001
[55] Scott and Reinhardt 2001
[56] Cruz et al. 2003
[57] Stratton 2004

- Managing the Impacts of Wildfires on Communities and the Environment (The National Fire Plan) (September 8, 2000)
- A Collaborative Approach For Reducing Wildland Fire Risks To Communities and the Environment: 10-Year Strategy Implementation Plan (December 2006)
- Forest Service Manuals 5100 and 2400

The strategy resulted in a set of scheduling of treatments across a 20-year period, with the focus on the first five years[58].

The analysis concluded that the project area and many adjacent lands are a high priority for treatment over the next five years. In other words, the existing conditions ranked high in terms of risk, hazard and value.

Desired Condition

Desired future conditions for the land allocation in which treatments would occur – MA 4 (Wilderness Management Areas) - are described in the Shasta-Trinity NF Land and Resource Management Plan (LRMP or Forest Plan) and in Forest Service Manual (FSM) 2300, Chapter 2320 – Wilderness Management. In summary, these desired future conditions are as follows:

- The risks and consequences of wildfire occurring within wilderness or escaping from wilderness are at an acceptable level (FSM 2324.21).
- The fuels condition allows for reduced fire behavior characteristics and enables wildfire suppression tactics to make use of natural barriers, topography or watercourses and minimum impact suppression techniques.
- Lightning-caused fires play, as nearly as possible, their natural ecological role within wilderness (FSM 2324.21), with an appropriate suppression response ranging from confinement to control[59] to protect public safety.
- The risks and consequences of public health and safety concerns caused by hazardous air conditions are reduced.

Environmental Consequences

Project Design Features

A complete description of project design features for all resources is located in Chapter 2 of the EA. A detailed prescribed fire implementation plan (burn plan) is required prior to conducting prescribed fire. The burn plan would include all elements required by Forest Service Manual (FSM) 5140 and the Interagency Prescribed Fire Planning and Implementation Procedures Guide.

[58] USDA Forest Service 2010
[59] LRMP page 4-17

Monitoring

Fire behavior during prescribed fire operations will be monitored and documented. Post-fire monitoring will be conducted as funding and Forest priorities allow.

Alternative 1 - No Action

Direct Effects and Indirect Effects

Under the No Action alternative, current management activities in the project area would continue as directed by the forest plan. With no change in current management of the project area under this alternative, there would be no direct effects.

Indirectly, implementation of this alternative would likely result in burn probabilities, predicted flame lengths and crown fire potential similar to existing conditions in the event of a future wildfire (see table 13 above and Maps 6-8 in Appendix B).

Wildland fires and associated suppression efforts that occurred over the past 15 years have created a large amount of fuels, both standing and down. Numerous snags and other vegetation were cut during construction of indirect fire lines, which the fires never reached, and in which no other fuels mitigations were implemented. These fire lines now have heavy accumulations of large, dead and downed woody debris. Many of them occur on ridgelines historically used to stop fires. The continued accumulation of untreated fuels increases the potential of high-severity re-burn within the project area.

This scenario played out during the Backbone and Red Spot fires of 2009, which burned approximately 6,900 acres, 49 percent of which exhibited moderate- to high-severity fire effects. The fire behavior resulting from unusually high accumulation of fuels increases a fire's intensity and the probability of spotting. It also produces a more challenging fire environment for firefighters to work in with the increased threat from rolling material and snags.

Past management within the project area has been limited to fire suppression. Typically, activity slash that is generated from fire line construction is chipped or piled during the suppression repair efforts, and then subsequently burned. However, slash within the project area was never treated for various reasons. Therefore, under this alternative existing slash along ridgelines would remain. Fuels and understory vegetation would continue to accumulate; especially as trees killed by the more recent wildfires become available for consumption as either standing or downed fuels in future wildfires.

As time passes, fall down of standing material killed during past fires combined with any subsequent mortality would continue to increase the surface fuel loading, particularly of larger diameter material. This downed, coarse woody debris would exhibit some decay and would support a long period of burning, resulting in high severity effects to vegetation and soils where it is present. In addition, regeneration of vegetation would provide a continuous surface fuel bed and ladder fuels that promote fire spread and increase crown fire potential. Currently, the fuel loading (dead and down) within the project area is estimated to be as high as 75 tons per acre and, when combined with standing dead material that is likely to fall in coming years, an additional 50 tons per acre may accumulate in some areas. (Insert photos here)

The continued accrual of large diameter fuels from recent wildfires within the project area would present problems to fire managers. This is often described by an adjective rating referred to as "resistance to control", which is an estimate of the fire suppression forces required to control a unit of fire perimeter.[60] Brown[61] indicates that large diameter fuel loading exceeding 45 tons per acre is defined as "extreme" resistance to control, with a "high" rating ranging from 25 to 45 tons per acre. This alternative would maintain or perhaps increase resistance to control by promoting a fire environment characterized by copious amounts of large diameter fuels and snags and early seral vegetation that provides continuous surface fuels and ladder fuels.

Cumulative Effects

Implementation of no action would have adverse effects on fire management activities by allowing the accumulation of fuels at levels that would increase the size, intensity and resistance to control of future wildfires. Implementation of this alternative would, therefore increase the risk to firefighter and public safety and the potential for damage to natural resource and cultural values during future wildfires. In addition, the potential of fire spread to and from the project area would increase.

Historically, approximately 90 percent of the analysis area supported vegetation at or below a fire return interval (FRI) of 20 years.[62] Given the historical FRI, the process to re-establish fire's natural role would be estimated to be between 40 and 60 years without any management influence – including prescribed fire and suppression of wildfires. However, in the absence of active management to reduce fuels, the Forest Service would have few options to manage future wildfires. Fire suppression within the project area would continue, which would further contribute to fire behavior and effects that are beyond what occurred historically. It is unlikely that a more historically accurate fire regime would return to the landscape and future wildfires would likely produce unacceptable effects to the project area's natural resources.

Alternative 2 – Proposed Action

Direct Effects and Indirect Effects

Under Alternative 2, approximately 16,709 acres within the project area would be treated with prescribed fire. The treatments would accomplish strategic fuels reduction along ridgelines, with fire backing down the slopes. The qualitative discussion of direct and indirect effects applies to Alternatives 2 and 3, and is presented below under *Effects Common to Both Action Alternatives.*

[60] Brown 1995
[61] Ibid.
[62] Safford et al. 2011

Indirectly, implementation of this alternative would likely result in burn probabilities, predicted flame lengths and crown fire potential in a future wildfire as displayed in table 14 and Maps 9-11 in Appendix B. For a complete description of categories found in Table 14 see the section titled, *Fire Behavior- Modeling Outputs*.

Table 14. Burn probabilities, predicted flame lengths, and crown fire potential before and after treatments in a future wildfire under Alternative 2*

	Alternative 2	**Very Low**	**Low (0-25%)**	**Moderate (26%-50%)**	**High (51%-75%)**	**Very High (76%-100%)**
Burn probability (acres)	Pre Treatment	N/A	5,689	6,399	3,487	1,108
	Post Treatment	N/A	4,344	7,352	4,011	1,002
Flame Length Potential (acres)	**Alternative 2**	**Very Low**	**Low (0-4 ft.)**	**Moderate (4-8 ft.)**	**High (8-12 ft.)**	**Very High (>12 ft.)**
	Pre Treatment	58	8,377	1,174	1,057	6,018
	Post Treatment	59	9,618	6,132	898	2
Crown Fire Potential (acres)	**Alternative 2**	**Non-Burnable**	**Surface Fire (acres)**	**Passive Crown Fire (acres)**	**Active Crown Fire (acres)**	
	Pre Treatment	58	8,248	7,434	945	
	Post Treatment	0	9,702	7,005	2	

*These figures assume a wildfire under 90th percentile weather conditions after proposed treatments have occurred.

** Re-projections made in ArcGIS due to the varying datum that initial layers and output data are projected to can lead to a geometry discrepancy of less than 1%. Process methodology is designed to minimize this error and data is presented as approximations.

Alternative 3 – Additional Treatment Areas

Direct Effects and Indirect Effects

In addition to all of the proposed treatments under the proposed action, Alternative 3 would reduce fuels in three areas in the Virgin Creek drainage, for a total of approximately 19,088 acres of fuels reduction. The additional treatments would target strategic ridgelines in that drainage. Indirectly, implementation of this alternative would likely result in burn probabilities, predicted flame lengths and crown fire potential in a future wildfire as displayed in table 15 and Maps 12-14 in Appendix B. For a complete description of categories found in Table 15 see the section titled, *Fire Behavior-Modeling Outputs*.

Table 15. Burn probabilities, predicted flame lengths, and crown fire potential in a future wildfire under Alternative 3*

	Alternative 3	**Very Low**	**Low (0-25%)**	**Moderate (26%-50%)**	**High (51%-75%)**	**Very High (76%-100%)**
Burn probability (acres)	Pre Treatment	N/A	6,410	7,139	4,312	1,201
	Post Treatment	N/A	4,962	8,207	4,774	1,145
Flame Length Potential (acres)	**Alternative 3**	**Very Low**	**Low (0-4 ft.)**	**Moderate (4-8 ft.)**	**High (8-12 ft.)**	**Very High (>12 ft.)**
	Pre Treatment	58	9437	1,357	1,286	6,924
	Post Treatment	71	10,977	7,022	1,013	5
Crown Fire Potential (acres)	**Alternative 3**	**Non-Burnable**	**Surface Fire (acres)**	**Passive Crown Fire (acres)**	**Active Crown Fire (acres)**	
	Pre Treatment	58	9,305	8,620	1,079	
	Post Treatment	0	11,059	8,024	5	

*These figures assume a wildfire under 90th percentile weather conditions after proposed treatments have occurred.

** Re-projections made in ArcGIS due to the varying datum that initial layers and output data are projected to can lead to a geometry discrepancy of less than 1%. Process methodology is designed to minimize this error and data is presented as approximations.

As noted above, the qualitative discussion of direct and indirect effects applies to both action alternatives and is discussed below in the section titled *Effects Common to Both Action Alternatives.*

Cumulative Effects

The cumulative effects of Alternatives 2 and 3 are essentially the same and are discussed below under Effects Common to Both Action Alternatives. However, the addition of three treatment areas under Alternative 3 would supplement the beneficial effects of Alternative 2. Future fires within the larger Virgin Creek drainage would become more self-regulated in size through interaction with previous treatments and/or fires. Additionally, Alternative 3 would provide more opportunities within strategic locations for firefighters to suppress future wildfire. Firefighters used some of these ridgelines during past wildfires (Megram, 1999, Backbone, 2009, Corral, 2013, River, 2015) and they will be needed again in the future.

Effects Common to Both Action Alternatives

Direct Effects

The moderated conditions under which prescribed fire would be implemented (e.g., higher fuel moistures, cooler temperatures, higher relative humidities, etc.) would safely reduce fuels accumulated from recent wildfires. Both action alternatives are predicted to reduce the total fuel available in the treated areas by as much as 68 percent, with large diameter fuels predicted to be reduced by as much as 58 percent.

There are risks associated with the use of prescribed fire. Escaped prescribed fire may cause unintended resource and economic damage. However, these occurrences are extremely rare relative to the large number of prescribed fires that are successful[63]. Implementing prescribed fire when climatic and fuel variables are optimal for the desired fire behavior increases the likelihood of successfully meeting objectives and reduces the risk of prescribed fire escapes.

Indirect Effects

The beneficial effects of prescribed fire on altering fuel structure and future wildfire behavior and effects have long been observed and reported.[64] [65] [66] Proposed treatments are designed to optimize the effectiveness of future wildfire suppression efforts and to reduce the impacts of future wildfires on natural resources and the public.

The severity of fire effects and difficulty of fire suppression in future wildfires are primarily associated with the total amount of fuel available[67] and environmental hazards to firefighters. As noted above, either action alternative would reduce current total fuel loads by as much as 68 percent and large diameter fuels by as much as 58 percent in the treated areas. Reducing the large diameter fuels that have accumulated in the wake of recent wildfires would greatly reduce both the likelihood of crown fire and predicted fire line intensities (Refer to *Vegetation* report for predicted vegetation severity effects).

Modeling outputs from FlamMap indicates that up to a 99 percent reduction in the potential for active crown fire in the treated areas would result from implementation of

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[63] Russell et al. 2004
[64] Vaillant et al. 2006
[65] Stratton 2004
[66] Finney 2001
[67] Skinner 2002

either action alternative. The high and very high flame length potential combined decreases by approximately 88% and there is a corresponding increase in low to moderate flame length potential by approximately 65-67%. This is beneficial because it results in lower fireline intensities and fire severity effects to vegetation. With the reduction in crown fire and high to very high flame lengths, resistance to control and the associated suppression efforts to control a fire is less. In addition, within treated areas, challenges to future suppression operations are reduced through the consumption of large diameter fuels, snags, and ladder fuels that contribute to higher resistance to control.

Modeling also shows a slight increase in burn probability of 5-10% related to the proposed treatments in both action alternatives. This is due to a trending of the fire environment to a more historically accurate landscape dominated by lighter fuel loading and less canopy density, which would allow for moderately increased rates of spread through lighter fuels carried by wind.

Smaller diameter fuels characterize post-implementation fuel loading, and the overall fuel loading would be significantly lower than current conditions. Suppression efforts under these conditions are more likely to be successful, even with increased spread rates, due to increased line production rates, decreased resistance to control and fire line intensity, and predicted low flame lengths.

Cumulative Effects

Under either action alternative, future wildfires would play a role more similar to that of historic conditions than under current conditions. Future fires within the project area would exhibit reduced fire behavior, fireline intensities, resulting fire severity effects to vegetation and resistance to control in areas where treatment has occurred. Conducting prescribed fire operations as proposed would begin the restoration of fire to the ecosystem in a more controlled manner, thus expediting the return to the historic fire regime and reducing the impacts on resources and the public from wildfires through a gradual reduction in accumulated fuels. Additional benefits would accrue considering ongoing and foreseeable actions, as described in the Environmental Assessment.

Implementation of either action alternative would moderate future fire behavior within the project area and reduce the risk that a wildfire originating in the project area would threaten adjacent public and private lands.

While fire suppression in the Trinity Alps Wilderness would continue in accordance with Forest policy and direction, the predicted improved fuel conditions would promote more self-regulated fire behavior, thereby reducing suppression costs and risks to firefighters and the public.

Both action alternatives would have beneficial effects to fire and fuels management by trending the landscape toward historic fuel conditions. Implementation of either action alternative would provide a safer environment for firefighters and reduce the adverse effects to natural resources and the public from future wildfires. With reduced fire behavior conditions in strategic locations future fires would be more manageable, with a suite of options available to fire managers to limit fire size and reduce suppression costs and risks to firefighters. Managing fuels in the project area through prescribed fire as proposed may facilitate future management of wildfires within the Trinity Alps Wilderness for resource benefits.

Air Quality

Issues and Issue Indicators

Issue: Project activities may cause adverse effects on air quality.

Issue Indicators:

- Predicted smoke emissions (PM_{10}, $PM_{2.5}$, and CO) for each alternative based on fuel loadings.
- Coordination with State and local air quality districts and subsequent compliance through smoke management plans and monitoring procedures.

Analysis Methodology

Methodology for Existing Condition

Fire hazard plays a critical role on air quality. Vegetation densities and fuel loading play a role in fire type, combustion phase, and fuel consumption – all of which affect air quality to varying degrees. Air quality can be evaluated in terms of visibility and the concentration of pollutants.

The Federal Clean Air Act, the Shasta-Trinity National Forest LRMP, and the California Air Resources Board regulate smoke producing activities on National Forest System lands. Standards established therein are also useful in measuring the impact of wildfires on air quality.

Methodology for Effects Analysis

Prescribed fire and unplanned ignitions result in smoke production. Smoke affects air quality and visibility during, and shortly following the event in which it is produced. These effects may be noticeable to residents and recreational users in the area, to adjacent communities, and in sensitive areas such as the Marble Mountain Wilderness Class I airshed and the Trinity Alps Wilderness Class II airshed. The area analyzed for cumulative effects to air quality is defined by a perimeter extended 15 miles from the project boundary. This encompasses communities and infrastructure that have been affected by past wildfire events through smoke intrusions, poor visibility and public health issues related to air quality.

The emissions and impacts of prescribed burning and wildfire on air quality are difficult to quantify because of the many site-specific factors involved: fuel type, fuel loading, moisture conditions, combustion rate, and meteorological conditions.

The Forest Service, Pacific Southwest Region recognize FOFEM as being the most current and accurate analysis tool available for emissions prediction[68]. It is based on extensive research in western forest ecosystems. FireFamilyPlus, a software program designed to analyze historical weather observations, was also used to refine FOFEM inputs and to assist in defining conditions for implementation.

FOFEM estimates emissions from a wildfire in the project area compared to prescribed fire for both flaming and smoldering phases. All three alternatives used the same fuel model, however fuel loading approximations changed between the no action and action alternatives. The wildfire scenario assumes drier conditions, while the prescribed fire scenario assumes moderate moisture conditions given the design features related to timing of ignition. In addition, implementation for the action alternatives and subsequent smoke production would only take place within a small amount of the project area in a given year (approximately 2,200 acres), whereas wildfire (no action alternative) may burn much of the project area within a few weeks to months.

Furthermore, emissions were modeled based on slope position, which relates to dryness of fuels. A combination of slope positions and fuel moistures were modeled, averaged, and the totals, in pounds per acre, are listed in Table 17.

Existing Condition

Air Basin and Local Overview

The project area is located within the North Coast Air Basin and is managed and regulated by the North Coast Unified Air Quality Management District (NCUAQMD), which consists of Del Norte, Humboldt, and Trinity counties. Additionally, portions of Siskiyou County could be affected by smoke since the project area is located on the county divide. The Northeast Plateau Air Pollution Control District manages air quality in Siskiyou County.

Under the authority of the California Code of Regulations Title 17, Subchapter 2, Smoke Management Guidelines for Agriculture and Prescribed Burning, the local air district issues permits for prescribed burning on agriculture and forested lands. In addition, the air district issues specific standards and guidelines for burn days, marginal burn days, and no burn days, defines permit requirements, and sets emission limits.

Location of Sensitive Sites

Class I airsheds include wilderness areas designated by the federal government prior to the 1997 amendments to the Clean Air Act, as well as, federally designated national monuments and other areas of special natural, recreational, scenic, or historic value. Class I designation applies to select pristine airsheds including national parks greater than 6,000 acres and wilderness areas greater than 5,000 acres. The Marble Mountain Wilderness is the only Class I airshed located within the cumulative effects analysis area for air quality. Class II airsheds are clean air areas where a moderate amount of development can be permitted. These include wilderness areas designated after 1977, in

[68] Reinhardt et al. 1997

which the Trinity Alps Wilderness is pertinent. Table 16 below identifies smoke-sensitive locations and their approximate air distance from the project area.

Table 16. Location and approximate air distance from project area and areas sensitive to smoke

Smoke Sensitive Location	Distance (air miles)
Denny	~ 2 Miles
Salmon River Communities (Cecilville, Forks of Salmon, Somes Bar, Sawyers Bar)	~6-15 Miles
Klamath and Trinity River Communities (Hoopa, Orleans, Weitchpec, Willow Creek, Salyer, Hawkins Bar, Burnt Ranch, Del Loma, etc.)	~11 – 15 Miles
Marble Mountain Wilderness (Class I Airshed)	~14 Miles

Air Quality Standards and Regulations

Air quality is managed through a series of regulations to assure compliance with the Clean Air Act. This includes a variety of federal, state, and local regulations. The Environmental Protection Agency (EPA) has the primary role of ensuring the Clean Air Act requirements are in compliance. The EPA issues national air quality standards and regulations, oversees and approves state implementation plans (SIP), and conducts major enforcement actions

In California, the California Air Resource Board (CARB) is responsible for meeting the Federal and State standards (Appendix C). The CARB has further delegated authorities to the Air Pollution Control Districts or Air Quality Management Districts for compliance at a more localized level. Therefore, these districts have the primary responsibility for meeting the requirements of the Clean Air Act. The districts provide an implementation plan to develop attainment and maintenance of air quality standards.

Federal Clean Air Act

The Clean Air Act of 1963 was amended in 1970, 1977 and 1990. The law was enacted to insure that air quality standards are attained and maintained.

Amendments to the Federal Clean Air Act

The Clean Air Act Amendments of 1970, section 109, required the EPA to develop primary Ambient Air Quality Standards to protect human health and secondary standards that protect public welfare from any known or anticipated adverse effects[69]. The National Ambient Air Quality Standards (NAAQS) were set for six criteria pollutants: Carbon Monoxide, Lead, Nitrogen Dioxide, Ozone, Particle Pollution (PM_{10}, $PM_{2.5}$), and Sulfur Dioxide (Appendix C). Currently, Trinity County is considered either in attainment or

[69] https://www.epa.gov/green-book

unclassified for criteria pollutants[70]. In other words, the project area currently does not exceed ambient air quality standards for regulated/monitored air pollutants.

The 1977 Federal Clean Air Act amendments directed Federal land managers to protect Air Quality Related Values (AQRV) of Class I areas from adverse air pollution impacts. Visibility is an AQRV that needs to be protected for all Class I areas but it is also important to all wildernesses, national parks, and monuments.

Prevention of Significant Deterioration (PSD) is mandated by the 1977 amendments to the Clean Air Act. These provisions prevent the growth of stationary industrial sources from causing significant deterioration of air quality in areas that meet the NAAQS (in attainment areas). The PSD requirements include actual monitoring of air quality conditions and placement of limits on the "increment" of clean air that can be used by industrial projects. PSD analysis is usually conducted for proposed industrial developments such as power plants or geothermal plants.

The Regional Haze Rule, released by the EPA in 1999, aims to protect the visibility in our National Parks and wilderness areas. Regional haze obscures the clarity, color, texture and form of what we see. Haze-causing pollutants consist of fine particles, which are emitted into the atmosphere. The Rule sets a long-term path towards attaining improved visibility, with the goal of achieving visibility, which reflects natural conditions by 2064. Unlike SIPs, which require specific targets and an associated timeline, the Regional Haze Rule requires states to submit a visibility attainment plan to the EPA outlining specific interim targets with attainment dates to ensure continual progress. CARB, in coordination with public land managers, completed a visibility attainment plan on January 22, 2009 and submitted it to the EPA for approval. The Plan was approved on June 14, 2011 and a later revision to the Plan was approved on May 1, 2015[71].

The conformity provisions of the Federal Clean Air Act, Section 176 [c], prohibit federal agencies from taking any action that causes or contributes to any new violation of the NAAQS, increases the frequency or severity of an existing violation, or delays the timely attainment of a standard. The Federal agency responsible for the action is required to determine if its actions conform to the applicable SIP. The conformity rule only applies to activities occurring in federal, non-attainment areas. Prescribed burns are exempt from conformity determination if the burn is under an approved smoke management plan. The implementation of prescribed burning within the Trinity Alps Wilderness Prescribed Fire Project would be implemented under an approved smoke management plan from NCUAQMD.

California Clean Air Act

The California Clean Air Act of 1988, amended in 1992, requires all air districts within the state to achieve and maintain state ambient air quality standards for the criteria pollutants (Appendix C). Generally, the state requirements for air quality standards are stricter than the federal standards. In addition, the state of California also established its own standards for sulfates, hydrogen sulfide, vinyl chloride, and visibility-reducing particles.

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[70] Ibid

[71] https://www.arb.ca.gov/planning/reghaze/reghaze.htm#progrep

The California Air Resource Board (CARB) administers the California Clean Air Act. One of the responsibilities of the CARB is to determine designated criteria and areas of the state as attainment, non-attainment, or unclassified. Currently, Trinity County is listed as either in attainment or unclassified for all criteria pollutants. Note that the conformity rule applies to federal actions for federal standards only.

State Implementation Plan (SIP)

State implementation plans are a subset of the air agency rules that deal with the attainment and maintenance of NAAQS. States and districts have the authority to make regulations and standards more stringent than at the federal level. This may include controls over certain pollutant sources to attain and maintain NAAQS.

Historic and Existing Condition

Air quality was noticeably poor at various times in Northern California in the summers of 1999, 2006, and 2008 due to large wildfires on the Shasta Trinity, Klamath, and Six Rivers National Forests. Monitoring at the community of Hoopa, California indicated that, because of the Big Bar Complex (1999), State 24-hour PM_{10} standards were exceeded on 19 days and the federal standard on 12 days. In addition, during several of these days, the average PM_{10} standards exceeded 420 $\mu g/m^3$ and such a level is considered hazardous. The smoke from the fires precipitated the first declared state of emergency in a California county due to air pollution[72].

As fire risk and high fire behavior potential in the analysis area increase, periods of poor air quality during wildfires are more likely to occur. All other things being equal, wildfire produces about twice the emissions of prescribed fire due to increased consumptions[73].

Environmental Consequences

Design Features

Implementation of prescribed fire would comply with applicable Federal, State, and NCUAQMD air quality laws and regulations concerning overall project emissions with emphasis on prescribed burning coordination, emissions, and smoke impacts mitigations. The following design features would be incorporated into either action alternative:

1. A smoke management plan would be developed in accordance with NCUAQMD direction and submitted/approved prior to implementation of prescribed fire.
2. Prescribed burning during periods of high public use would be avoided or mitigated through smoke management procedures that minimize impacts to areas of high public use.

[72] Herr 1999
[73] Ottmar et al. 1998

Mitigation and Monitoring

NCUAQMD would monitor their sensors for air quality during and following project implementation to ensure compliance with state and federal air quality standards. The results of the monitoring would be published on the NCUAQMD website and in an annual report summarizing all activities within the district.

Alternative 1 – No Action

Direct and Indirect Effects

No direct effects to air quality would occur with implementation of the No Action alternative, since no prescribed fire would be implemented.

With current management strategies in place, air quality would remain at current levels in the absence of a wildfire. However, the likelihood of recurring large wildfires would increase under this alternative, and the continued accumulation of fuels would hamper future suppression efforts. As a result, future wildfires in the project area are likely to be of longer duration and more severe than under either action alternative. These wildfires would occur:

- Within a landscape where large diameter fuel loadings that are higher than what historically occurred would be consumed. With more available fuels to burn, the amount of smoke produced would be greater.
- With higher levels of large, diameter fuels consumed over a longer period. Emissions under such a scenario is predicted to occur for much longer than would be typical of historic conditions.
- When air quality and meteorological conditions are unpredictable, thus leading to the potential for large amounts of smoke production under less than optimum conditions for dispersal.
- When wildfires are likelier to burn for longer periods with less success in suppression operations and increased resistance to control.

Air quality conditions under the no action alternative would, therefore, be similar to current conditions but with periods of severe degradation during wildfires in the summer months. As demonstrated by recent wildfires, air quality standards could at times be in non-compliance with federal, regional, and local standards. In addition, smoke is expected to have adverse effects to surrounding communities, potentially for many weeks at a time.

Cumulative Effects

As noted above, air quality under the no action alternative would be maintained at current levels, but with periods of extremely poor conditions during wildfires that would likely be large, severe, and of long duration. Implementation of this alternative would increase the potential for protracted periods of poor air quality during future wildfires, which in turn would increase health hazards to firefighters and the public.

Alternative 2 – Proposed Action

Direct Effects

Emission estimates for Alternative 2 were quantified using FOFEM. The results of the calculations are displayed in table 17 and represent the predicted direct effects. A qualitative discussion of direct effects under this alternative is presented below.

Table 17. Predicted smoke emissions in lbs./acre for no action during a wildfire, for the action alternatives during prescribed fire, and after treatments are completed during a wildfire

Emissions	No Action (with/wildfire)*	Alternatives 2 and 3 (during prescribed fire)**	Alternatives 2 and 3 (post treatments with/wildfire)***
PM_{10}	3,494	3,118	1,550
$PM_{2.5}$	2,961	2,642	1,313
CO	37,857	34,970	17,443
CH_4	1,791	1,598	797
CO_2	176,270	157,092	74,568
NO_x	31	27	7
SO_2	139	124	60
Total	222,543	199,571	95,738

*Emissions for a wildfire under no action reflect a one-time wildfire event.
**Emissions under the action alternatives during prescribed fire would be stretched out over approximately ten years with approximately 2,200 acres burned per year.
***Emissions for a wildfire after treatments are complete are a one-time wildfire event.

Alternative 3 – Additional Treatment Areas

Direct Effects

Emission estimates for Alternative 3 were quantified using FOFEM. The results of the calculations are displayed in table 17 and represent the predicted direct effects. The qualitative discussion of direct effects under this alternative is presented below under *Effects Common to Both Action Alternatives.*

Effects Common to Both Action Alternatives

Direct Effects

Wildfire and prescribed burns are sources of forest air pollutants. Either action alternative would generate short-term smoke emissions suspended in the atmosphere from prescribed burning. Emission rates vary by fuel consumption and related factors including fuel loading, fuel moisture, ignition patterns, and length of combustion phases. It is generally accepted that smoke production from prescribed fires is of shorter duration and of lesser amounts than from wildfires occurring in similar vegetation types during unpredictable meteorological conditions and fuel moistures (e.g., high winds, hot temperatures, and low humidities) during a typical fire season[74].

The major air pollutant of concern from prescribed fires is the smoke produced by the fire. Smoke is comprised of fine particulates (measured as PM_{10} and $PM_{2.5}$), carbon monoxide, carbon dioxide, nitrogen dioxides, etc. Particles over about 10 microns, consisting of ash and partially burned plant matter, are mostly associated with high-intensity fires and remain suspended in air for only a short period. Particulate emissions depend on duration of combustion phases (preheating, flaming, glowing, and smoldering), fuel moisture, rate of energy release, and type of fuel consumed.

Predicted smoke emissions from prescribed burning treatment, proposed in Alternatives 2 and 3, are estimated to be slightly less (10% reduction) than during a wildfire under the no action alternative (see Table 17). The significance lies in the difference in the amount of acres that burn because prescribed fire treatments would occur across approximately 10 percent of any sixth-field watershed (approximately 2,200 acres) per year stretched out over ten years. Whereas, a wildfire could potentially consume up to 100,000 acres over a two to three-month period as what occurred in 2008, 2006, and 2015. Since the number of acres burned during either action alternative can be controlled through the amount of ignition, and occur when meteorological conditions are favorable, adverse impacts to sensitive areas near the project area are not expected to happen.

Estimated 24-hour emissions may exceed the 24-hour standard (California) for PM_{10} and $PM_{2.5}$ in sensitive areas; but they would not be expected to exceed annual State or Federal standards, and would not degrade air quality or attainment status. Certainly, the duration of these exceedances would be less than what would occur during a wildfire scenario in the same area under the no action alternative. Emission estimates are the same for both action alternatives; however, since they are described in pounds per acre Alternative 3 would have more emissions due to it being a larger area. For example, Alternative 3 would treat approximately 2,379 acres more than Alternative 2.

Smoke emissions during prescribed burning may temporarily reduce visibility in some locations within the project area and surrounding drainages, but are not likely to affect overall visibility trends at the annual and decadal scale. Reduced visibility could affect wilderness visitors and nearby residents in communities located adjacent to the project area, such as Denny, Cecilville, and Hoopa for short periods during and immediately after implementation. However, by utilizing sound smoke management practices, and burning during favorable weather conditions, when smoke is carried away from Class I and II

[74] NWCG 2001

airsheds and other sensitive areas, visibility impairments can be minimized. Smoke emissions, such as PM_{10} and $PM_{2.5}$, from prescribed burning would contribute to local air basin and broader regional pollutant loading, but contributions would be confined to remote areas and would be unlikely to influence design values for NAAQS at local air district monitoring sites.

Project activities would only occur following a prescribed fire implementation plan (i.e., burn plan), which stipulates fuels and meteorological conditions under which a prescribed fire may be ignited. Coordination with air-quality management officials, meteorologists, and fire management cooperators is mandated by agency policy and regulations. As the extent and timing of ignition greatly influence smoke production and management, implementation would take place when proper meteorological circumstances occur for dispersion purposes (e.g., favorable wind direction, adequate transport winds, etc.) Long periods of poor air quality resulting from implementation of either action alternative are unlikely.

Indirect Effects

Emissions during a wildfire, immediately after proposed treatments are completed, would result in a 57% reduction compared to predicted emissions during a wildfire under the no action alternative. The completed treatments would aid in future wildfire suppression efforts by giving fire managers more options for active management in the project area – such as implementing firing operations on days that favor optimal smoke dispersal.

As the project area trends toward historic fuel loading levels, smoke production during future wildfires would decrease due to less fuel being available for consumption and fewer active days that a fire would be expected to burn. Wildfires occurring within the treated areas would likely experience even greater reductions in smoke production, largely due to the reduced large diameter fuels, compared to untreated portions of the project area.

Cumulative Effects

With implementation of either action alternative, the potential for long periods of severely degraded air quality during future wildfires would be lower than under the no action alternative (Table 17). While short-term increases in smoke production during implementation would be expected to occur, prolonged periods of very poor air quality that have characterized recent wildfires would be much less. In summary, both action alternatives would ultimately have primarily beneficial effects to air quality by trending the landscape toward historic fuel loads and, consequently, fire frequencies and fire behavior.

Vegetation

Introduction

Limitations within the Wilderness Act legislation preclude the use of vegetation treatments within designated wilderness other than prescribed fire, except as reserved by the Chief of the Forest Service.[75] Therefore, vegetation management in the project area is designed to support other ecosystem goals within the Trinity Alps Wilderness. The action alternatives were designed to provide the benefits to the ecosystem of fire while reducing its risks to project area resources, and to modify surface and ladder fuels to reduce the severity of future wildfires in the project area. The discussion of vegetation reflects the discussion of fire and fuels, with emphasis on the contributions of vegetation composition and structure to potential fire behavior and the effects of prescribed fire and wildfire on vegetation fire severity.

Vegetation in the project area has recently burned in wildland fires. Vegetation fire severity effects in these recent fires are discussed to provide a reference for effects analysis under all alternatives. The Iron-Alps Complex resulted in vegetation fire severity effects (see Table 7 similar in most instances to those from a prescribed fire (see the Environmental Consequences section below). However, air quality was severely degraded for several weeks during that fire (see the Air Quality section of this report). Vegetation fire severity from the Backbone Fires (see Table 21) was higher than would be anticipated in prescribed fire and similar to vegetation fire severity that would be expected in a future wildland fire in the absence of treatment.

Existing condition

Analysis Methodology

Vegetation Classification

Classification of vegetation in the project area was derived from ‘Ecological Subregions of California: Section and Subsection Descriptions’[76] and was further refined using the Regional Dominance Types description.[77] This scheme classifies vegetation alliances, and provides context to understand the vegetation resource. The project area overstory vegetation was classified using regional dominance type classification, from the 2007 CALVeg Eveg layer.[78]

Vegetation Fire Severity

Post fire vegetation conditions have been formally assessed following an established protocol in Region 5 since 2007, and nationwide since 2008. A Rapid Assessment of

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[75] USDA Forest Service 2007
[76] USDA Forest Service 1997
[77] USDA Forest Service 2008
[78] This Existing Vegetation (Eveg) polygon layer completed Classification and Assessment with LANDSAT of Visible Ecological Groupings (CALVEG) map product at a scale of 1:24,000; it updates and revises the 2003 data for Shasta-Trinity NF administrative areas, including private land inholdings.

Vegetation Condition after Wildfire (RAVG) analysis looks at fires that have burned more than one thousand acres of National Forest System (NFS) forested lands. Forested lands are defined as lands capable of growing trees. RAVG products are generated for NFS lands (including wilderness) to provide information that can assist post-fire vegetation management planning designed to address a number of management objectives. The primary benefit is cost-effective, efficient, and precise identification of potential resource concern areas following wildfire. The RAVG products produced at the Remote Sensing Applications Center (RSAC) include the following for each wildfire processed:

- Map and GIS products showing location of basal area loss within fire perimeter.
- Summary table of vegetation affected by the fire, separated into four classes of basal area loss.

The RAVG products can assist the Forests' decision-making capabilities and reduce planning and implementation costs associated with post-fire vegetation management. RAVG compliments the Burned Area Emergency Rehabilitation (BAER), which provides information about fire effects to soil, by including information about fire effects to existing vegetation[79].

NFS lands experience thousands of wildfires every year, most of which are relatively small. The largest fires typically account for ninety percent of the total acreage burned. RAVG analysis provides a first approximation of areas that may require reforestation treatments due to severity of the fire. These reforestation treatments would re-establish forest cover and restore associated ecosystem services. This initial approximation could be followed by a site-specific diagnosis and development of a silvicultural prescription identifying reforestation needs[80].

General descriptions of the severity classes are:

- Unchanged: This means the area one year after the fire was indistinguishable from pre-fire conditions. This does not always indicate the area did not burn.
- Low: Represents areas of surface fire with little change in cover and 0-25 percent mortality of the structurally dominant vegetation.
- Moderate: This severity class means there is a mixture of effects on the structurally dominant vegetation, with 26-75 percent mortality.
- High: Represents areas where the dominant vegetation has high to complete (over 75 percent) mortality.

Ecological Subregions Classification of the Project Area

Classification of the project area into ecological subregions assists in understanding overall site quality. Site quality is the sum of many environmental factors including: soil depth, soil texture, profile characteristics, mineral composition, steepness of slope,

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[79] Text was directly excerpted from: http://www.fs.fed.us/postfirevegcondition/

[80] RAVG data are not available for Region 5 (California) prior to 2008. Visit the U.S. Forest Service Pacific Southwest Region: The Threat of Deforested Conditions in California's National Forests website at http://www.fs.fed.us/r5/rsl/projects/postfirecondition/ for information prior to 2008.

aspect, microclimate, species and others. These factors are a function of geologic history, physiography, macroclimate and successional development.

The project area is part of a larger ecological subregion. As shown in table 18 below, the entire project area lies within the Humid Temperate domain, the Mediterranean division, Sierran-Steppe Mixed Conifer Forest province in the Klamath Mountains section. Within the Klamath Mountains section there are twenty-one distinct subsections. The Trinity Alps Prescribed Fire Project lies within two of these subsections, the North Trinity Mountain and Trinity Mountain Hayfork subsection. The Trinity Mountain-Hayfork subsection accounts for approximately 67 percent of the project area, with the remaining 33 percent located in the North Trinity Mountain subsection. Map 15 in Appendix B displays the project area in relationship to subsections. For a description of the subsections, refer to the publication entitled 'Ecological Subregions of California: Section and Subsection Descriptions'.[81]

Table 18. Ecological subregions classification of the Trinity Alps project area.

Hierarchal structure	Code	Name	Acres	Percentage of project area
Domain	200	Humid Temperate	58,349	100%
Division	260	Mediterranean	58,349	100%
Province	M261	Sierran-Steppe Mixed Conifer Forest	58,349	100%
Section	M261A	Klamath Mountains	58,349	100%
Subsection	M261Ar	Trinity Mountain-Hayfork	39,218	67%
Subsection	M261Aq	North Trinity Mountain	19,131	33%

The project area overlies approximately 11.8 percent of the entire North Trinity Mountain subsection and just less than eight percent of the entire Trinity Mountain-Hayfork subsection. The subsection is the only notable scale in the classification system where differences can be seen within the project area. The subsection is described by predominant environmental, biological and other characteristic features. More detailed information regarding each ecological subregion can be found in the above-named publication, including lithology and stratigraphy, geomorphology, soils, climate, and surface water.

[81] USDA Forest Service 1997, pp.5-15 to 5-16

Vegetation in the Project Area

Vegetation within the project area is described in the New River Watershed Analysis (WA) by dominant plant communities and seral stage. The information provided in the WA concerning factors that influence vegetation patterns is still valid; however vegetation classification may have changed somewhat due to two major factors – the time that has elapsed since the completion of the WA and the more current Geographic Information System (GIS) layers used for analysis in this report.

Vegetation in the Trinity Alps project area is comprised primarily of tree-dominated stands - both conifer and hardwood. Tree-dominated[82] stands account for approximately 50,406 acres, or 86 percent of the project area.

Conifer and hardwood species present in the project area include[83]:

- Douglas-fir (*Pseudotsuga menziesii)*
- white fir (*Abies concolor*)
- sugar pine (*Pinus lambertiana*)
- Jeffery pine (*Pinus jefferyii*)
- red fir (*Abies magnifica*)
- ponderosa pine (*Pinus ponderosa*)
- incense cedar (*Calocedrus decurrens*)
- California black oak (*Quercus kelloggii*)
- canyon live oak (*Quercus chrysolepis)*
- bigleaf maple (*Acer macrophyllum*)
- Pacific madrone (*Arbutus menziesii)*
- California bay (*Umbellularia californica*)
- tree chinquapin (*Chrysolepis chrysophylla*)
- knobcone pine*(Pinus attenuate)*
- alder species (*Alnus spp.)*

The understory vegetation in the conifer stands consists of shrubs, perennial and annual forbs and grasses. These species are discussed further in the Trinity Alps project Botany Report (see the project file).

Regional Dominance Types in the Project Area

Various attributes classifying vegetation are present in the geographic information systems (GIS) layer used for analysis. For the purposes of this report, regional dominance type was selected to quantify acres of overstory dominant vegetation in the project area. Regional dominance types in the project area are displayed in table 19 below. They are displayed in categories, with the conifer forest/woodland and hardwood forest/woodland categories representing the forested stands, or approximately ninety-two

[82] A tree-dominated classification indicates that the stand historically has supported and is capable of growing trees.
[83] While Port Orford cedar (*Chamaecyparis lawsoniana*) is found within the Trinity Alps Wilderness, no known sites exist within the project area. Therefore, a Port Orford cedar risk analysis is not required (Forest Plan, p. 4-18).

percent of the project area. The remaining eight percent of the project area is represented by the shrubs and chaparral, herbaceous and non-forested categories. Of these, the non-forest, or barren category accounts for less than one percent of the project area.

Table 19. Regional dominance type vegetation classification types in the project area by acres and percentage of project area*

Regional dominance type symbol	Alliance name	Acres	Percentage of project area
Conifer Forest/Woodland			
DF	Pacific Douglas-fir	27,590	47
DW	Douglas-fir White fir	8,460	15
WF	White fir	7,736	13
KP	Knobcone Pine	1	<1
MP	Mixed Conifer- Pine	2,809	5
RF	Red fir	2,139	4
MF	Mixed Conifer-Fir	866	1
DP	Douglas-fir Ponderosa Pine	469	<1
SA	Subalpine conifer	329	<1
PP	Ponderosa Pine	7	<1
Subtotal Conifer Forest/Woodland		**50,406**	**86%**
Hardwood Forest/Woodland			
QC	Canyon Live Oak	2,488	4
QT	Tanoak (Madrone)	763	1
QK	Black Oak	261	<1
QM	Bigleaf Maple	157	<1
NR	Riparian Mixed Hardwood	69	<1
QW	Interior Live Oak	12	<1
QE	White Alder	8	<1
QO	Willow	6	<1
QG	Oregon White Oak	6	<1
QY	Willow – Alder	5	<1
Subtotal Hardwood Forest/Woodland		**3,775**	**7%**
Shrubs and Chaparral			
CX	Upper Montane Mixed Chaparral	3,337	6

Regional dominance type symbol	Alliance name	Acres	Percentage of project area
CM	Upper Montane Mixed Shrub	49	<1
CN	Pinemat Manzanita	199	<1
CQ	Lower Montane Mixed Chaparral	42	<1
CH	Huckleberry Oak	60	<1
NM	Riparian Mixed Shrub	22	<1
TA	Mountain Thinleaf Alder	18	<1
CL	Wedgeleaf Ceanothus	7	<1
Subtotal Shrubs and Chaparral		**3,734**	**6%**
Herbaceous			
HG	Annual Grasses and Forbs	102	<1
HJ	Wet Meadows	13	<1
Subtotal Herbaceous		115	<1
Non-vegetated/other			
BA	Barren/Rock	141	<1
Subtotal Non-vegetated/other		**141**	<1
Total All Alliances		**58,349**	**100%**

* Categories include Conifer Forest/Woodland, Hardwood Forest/Woodland, Shrubs and Chaparral, Herbaceous, and Non-Vegetated.

Table 19 above classifies the vegetation in 2007, prior to the recent fires (i.e. Backbone, Iron Alps Complex, Corral and River Complex) within the project area. The vegetation fire severity section illustrates changes as a result of fires after 2007 only within the project area, to maintain the same scale of analysis. The overall fire acres affected are much greater for the wildland fires. Vegetation fire severity is further detailed in the Existing Conditions for vegetation in this report.

Regional dominance types accounting for greater than ten percent (5,835 acres) of the project area are considered 'major' for the purposes of this report. These include only three regional dominance types and they are described below:

- The Pacific Douglas-Fir Alliance accounts for approximately 27,607 acres, or 46 percent of the project area.
- The Douglas-Fir - White fir Alliance accounts for another 8,653 acres, or 15 percent of the project area.
- The White Fir Alliance takes in another 7,642 acres, or 13 percent of the project area.

These three major regional dominance types comprise approximately 74 percent of the project area. From this it can be concluded that the project area is primarily a forested habitat.

The alliance descriptions are derived from the website listed below and include all areas where the regional dominance type is present. The descriptions are not necessarily specific to the project area, but rather represent the classification of vegetation throughout the entire range of each alliance. A detailed description of all regional dominance types in the project area can be found at this website: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_046448.pdf.[84] The project area also supports minor amounts of 28 additional alliances that together account for only about 25 percent of the project area. These alliances were therefore not discussed in detail. Descriptions of these minor alliances can be found at the above website.

Pacific Douglas-Fir Alliance

Douglas-fir is the dominant overstory conifer over a large area in the Mountains, Coast, and Ranges Sections. This alliance has been mapped at various densities in most subsections of this zone at elevations usually below 5600 feet (1708 m). Sugar pine is a common conifer associate in some areas. Tanoak (*Lithocarpus densiflorus* var. *densiflorus*) is the most common hardwood associate on mesic sites towards the west. Along western edges of the Mountains Section, a scattered overstory of Douglas-fir often exists over a continuous Tanoak understory with occasional madrone. When Douglas-fir develops a closed-crown overstory, Tanoak may occur in its shrub form (*L. densiflorus* var. *echinoides*). Canyon live oak becomes an important hardwood associate on steeper or drier slopes and those underlain by shallow soils. Black oak may often associate with this conifer but usually is not abundant. In addition, any of the following tree species may be sparsely present in Douglas-fir stands: redwood (*Sequoia sempervirens*), ponderosa pine, incense cedar, white fir, Oregon white oak, bigleaf maple, California bay

[84] USDA Forest Service 2008 (webpage accessed on December 19, 2018)

(*Umbellularia californica*), and tree chinquapin (*Chrysolepis chrysophylla*). The shrub understory may also be quite diverse, including huckleberry oak (*Quercus vaccinifolia*), salal (*Gaultheria shallon*), California huckleberry (*Vaccinium ovatum*), California hazelnut (*Corylus cornuta* var. *californica*), poison oak (*Toxicodendron diversilobum*), oceanspray (*Holodiscus discolor*), hairy honeysuckle (*Lonicera hispidula*) and a wide range of other shrubs and forbs.

Douglas-Fir – White Fir Alliance

Upper elevations of the Douglas-fir distribution often contain abundant but not dominant white fir in the upper canopy, but not enough species diversity to support a mixed conifer type. The type in which both conifers dominate the conifer overstory is generally found below about 6400 feet (1952 m) in all three sections. Conifers such as ponderosa pine, Port Orford cedar, and sugar pine are often present in minor amounts, and tree chinquapin and bigleaf maple are often present as understory hardwoods. Shrub or tree tanoak may be present in the western areas along with Sadler oak (*Quercus sadleriana*), a shade-tolerant shrub. The shrubs California hazelnut and Pacific dogwood (*Cornus nuttallii*) are often present as well as an occasional black or canyon live oak in these stands. The Douglas-fir - White Fir type grades into the Douglas-fir, Mixed Conifer - Pine and White Fir types.

White Fir Alliance

Sites dominated by white fir in the conifer overstory and understory occur broadly in all twenty subsections of the Mountains Section, prominently in the Eastern Franciscan Subsection of the Coast Ranges Section, and sparsely in two other subsections. Elevations are usually below 7000 feet (2170 m), being lowest towards the west. The White Fir type usually is found below Red Fir and above Mixed Conifer - Fir forests. Douglas-fir and red fir (*A. magnifica*) may be common associates at lower and upper elevations, respectively. Understory shrubs and hardwoods are uncommon due to the density of these stands. Shrubs of the Upper Montane Mixed Chaparral and Shrub Alliances may occasionally be present in forest openings, including huckleberry oak, pinemat manzanita (*Arctostaphylos nevadensis*), bush chinquapin (*Chrysolepis sempervirens*), greenleaf manzanita (*A. patula*), mountain whitethorn (*Ceanothus cordulatus*), Brewer oak (*Q*uercus *garryana* var. *breweri*), bitter cherry (*Prunus emarginata*) and, on moist sites, mountain alder (*Alnus incana* ssp. *tenuifolia*).

Vegetation Fire Severity

Vegetation fire severity acres from recent wildland fires within the project area are considered to predict the likely behavior of prescribed fires and of future wildland fires under each alternative. The fires summarized in the RAVG process occurred during the wildland fire season. Wildland fire season is the time of year when fires are anticipated to burn with the most detrimental overall resource effects. Resource effects to vegetation are interpolated from wildland fire effects. Model predictions for prescribed fire purposes were also utilized to understand wildland fire effects. The RAVG data has been summarized by fire within the project area as part of the analysis of anticipated vegetation effects.

Iron Alps Complex

On June 21, 2008 the Carey Fire was reported; this fire would later be managed as part of the larger Iron Alps Complex. The Carey Fire burned approximately 3,708 acres in the central and western portions of the project area (see Map 4 in Appendix B). RAVG analysis from this fire was conducted, and the results are summarized in table 20 below.

Table 20. Iron Alps Complex vegetation fire severity by alliance within the Trinity Alps Prescribed Fire Project area*

Alliance symbol	Alliance name	Unchanged Acres	Low severity acres	Moderate severity acres	High severity acres	Total alliance acres	Percentage of burned area
Conifer Forest/Woodland							
DF	Pacific Douglas-fir	884	566	259	213	1,921	50%
DW	Douglas-fir White fir	265	165	95	58	583	15%
WF	White fir	143	124	42	17	326	8%
RF	Red fir	123	66	39	26	255	7%
DP	Douglas-fir Ponderosa Pine	31	46	23	5	105	3%
MF	Mixed Conifer-Fir	31	25	9	16	82	2%
MP	Mixed Conifer-Pine	58	10	2	0	71	2%
SA	Subalpine conifer	27	16	9	5	56	1%
Subtotal Conifer Forest/Woodland		**1,562**	**1,018**	**478**	**340**	**3,399**	**88%**
Hardwood forest/woodland							
QC	Canyon Live Oak	104	51	25	20	200	5%
QT	Tanoak (Madrone)	12	8	5	0	25	1%
QE	White Alder	2	2	1	0	5	<1%
Subtotal Hardwood Forest/Woodland		**118**	**61**	**31**	**20**	**230**	**6%**
Shrub and chaparral							
CX	Upper Montane Mixed Chaparral	50	50	43	27	170	4
CN	Pinemat Manzanita	12	9	3	0	25	1

Alliance symbol	Alliance name	Unchanged Acres	Low severity acres	Moderate severity acres	High severity acres	Total alliance acres	Percentage of burned area
CQ	Lower Montane Mixed Chaparral	2	4	1	2	9	<1
Subtotal shrub and chaparral		**64**	**63**	**47**	**29**	**204**	**5%**
Herbaceous							
HG	Annual Grasses and Forbs	14	6	5	4	28	<.1%
BA	Barren	8	6	1	0	13	<.1%
Subtotal herbaceous		**22**	**12**	**6**	**4**	**41**	**<1%**
Total All Alliances		**1,766**	**1,154**	**562**	**393**	**3,874**	**100%**
Percentage by severity class		**45%**	**30%**	**15%**	**10%**	**100%**	

*The severity data is remotely sensed, using the RAVG process. Acreage differences between the RAVG data and fire perimeter GIS acreage are due to differences in the way data is obtained, and polygon acres versus raster data acres.

Backbone Fire

On July 1, 2009 as a weather pattern with significant lightning moved across northern California, three individual fires – the Redspot, Trinity and LT-17 fires – were ignited within the project area. These fires would later be managed as part of the greater Backbone Complex. The Trinity Fire totaled approximately 391 acres, but was later consumed by the LT-17 Fire. The three fires together consumed a reported total of 4,898 acres. Acres consumed were entirely within the perimeter of the 1999 Megram Fire, which was a large, severe wildland fire. See table 21 below.

Table 21. Backbone Fire vegetation fire severity by alliance within the Trinity Alps Prescribed Fire Project area*.

Backbone Vegetation Fire Severity by Alliance							
Alliance symbol	**Alliance name**	**Unchanged Acres**	**Low severity acres**	**Moderate severity acres**	**High severity acres**	**Total alliance acres**	**Percentage of fire perimeter area**
Conifer Forest/Woodland							
WF	White fir	518	264	273	572	1,627	33%
DF	Pacific Douglas-fir	384	254	208	415	1,261	25%
MP	Mixed Conifer-Pine	164	102	93	290	649	13%
RF	Red fir	210	77	74	243	604	12%
DW	Douglas-fir White fir	155	86	68	87	396	8%
SA	Subalpine conifer	3	2	7	61	73	1%
MF	Mixed Conifer-Fir	9	9	9	11	37	1%

Backbone Vegetation Fire Severity by Alliance							
Alliance symbol	**Alliance name**	**Unchanged Acres**	**Low severity acres**	**Moderate severity acres**	**High severity acres**	**Total alliance acres**	**Percentage of fire perimeter area**
Subtotal Conifer Forest/Woodland		**1,443**	**794**	**732**	**1,679**	**4,647**	**94%**
Hardwood forest/woodland							
NM	Riparian Mixed Shrub	17	3	2	1	22	<1%
QC	Canyon Live Oak	7	2	1	1	11	<1%
QM	Bigleaf Maple	2	2	1	3	9	<1%
NR	Riparian Mixed Hardwood	2	0	0	0	2	<1%
QY	Willow – Alder	1	0	0	0	1	<1%
Subtotal Hardwood Forest/Woodland		**29**	**7**	**4**	**5**	**45**	**<1%**
Shrub and chaparral							
CX	Upper Montane Mixed Chaparral	62	18	15	68	163	3%
CM	Upper Montane Mixed Shrub	28	14	5	32	79	2%
CH	Huckleberry Oak	12	0	2	0	14	<1%
CQ	Lower Montane Mixed Chaparral	0	0	0	1	1	<1%
Subtotal shrub and chaparral		**102**	**32**	**22**	**101**	**257**	**5%**
Herbaceous							
HG	Annual Grasses and Forbs	Severity unclassified due to limited acres affected				1	<.1%
Subtotal herbaceous						**1**	**<.1%**
Total All Alliances		**1,574**	**833**	**758**	**1,785**	**4,950**	**100%**
Percentage by severity class		**32%**	**17%**	**15%**	**36%**	**100%**	

*The severity data is remotely sensed, using the RAVG process. Acreage differences between the RAVG data and fire perimeter GIS acreage are due to differences in the way data is obtained, and polygon acres versus raster data acres.

Corral Complex

In August of 2013, multiple natural ignitions grew together to form the Corral Complex, which eventually would burn 800 acres into the project area, including 125 acres identified for treatment under both alternatives. RAVG analysis from this fire was conducted, and the results are summarized in table 22 below.

Table 22. Corral Complex vegetation fire severity by alliance within the Trinity Alps Prescribed Fire Project area*.

Alliance symbol	Alliance name	Unchanged Acres	Low severity acres	Moderate severity acres	High severity acres	Total alliance acres	Percentage of burned area
Conifer Forest/Woodland							
DF	Pacific Douglas-fir	326	70	25	15	436	51%
WF	White fir	107	28	11	11	157	19%
DW	Douglas-fir White fir	70	12	4	6	92	11%
RF	Red fir	19	3	1	<1	23	3%
MP	Mixed Conifer-Pine	5	1	<1	<1	6	<1%
Subtotal Conifer Forest/Woodland		**527**	**114**	**41**	**33**	**714**	**84%**
Hardwood forest/woodland							
QC	Canyon Live Oak	11	14	10	6	41	5%
NR	Montane Riparian	1	1	<1	0	2	,1%
Subtotal Hardwood Forest/Woodland		**12**	**15**	**10**	**6**	**43**	**5%**
Shrub and chaparral							
CX	Upper Montane Mixed Chaparral	65	14	5	5	89	11%
Subtotal shrub and chaparral		**65**	**14**	**5**	**5**	**89**	**11%**
Total All Alliances		**604**	**143**	**56**	**44**	**847**	**100%**
Percentage by severity class		**71%**	**17%**	**7%**	**5%**	**100%**	

*The severity data is remotely sensed, using the RAVG process. Acreage differences between the RAVG data and fire perimeter GIS acreage are due to differences in the way data is obtained, and polygon acres versus raster data acres

River Complex

In July of 2015, multiple natural ignitions grew together to form the River Complex, which eventually would burn 6,055 acres into the project area, including 2,285 acres identified for treatment under both alternatives. RAVG analysis from this fire was conducted, and the results are summarized in table 23 below.

Table 23. River Complex vegetation fire severity by alliance within the Trinity Alps Prescribed Fire Project area*.

Alliance symbol	Alliance name	Unchanged Acres	Low severity acres	Moderate severity acres	High severity acres	Total alliance acres	Percentage of burned area
Conifer Forest/Woodland							
DF	Pacific Douglas-fir	2282	921	418	321	3942	65%

Alliance symbol	Alliance name	Unchanged Acres	Low severity acres	Moderate severity acres	High severity acres	Total alliance acres	Percentage of burned area
DW	Douglas-fir White fir	162	104	71	84	421	7%
WF	White fir	160	77	78	292	607	10%
DP	Douglas-fir Ponderosa Pine	18	1	0	0	19	<1%
MP	Mixed Conifer-Pine	51	32	42	93	218	4%
Subtotal Conifer Forest/Woodland		**2673**	**1,135**	**609**	**790**	**5207**	**87%**
Hardwood forest/woodland							
QC	Canyon Live Oak	122	84	32	31	269	4%
QT	Tanoak (Madrone)	57	49	14	11	131	2%
QM	Bigleaf Maple	<1	<1	<1	21	22	<1%
Subtotal Hardwood Forest/Woodland		**180**	**133**	**46**	**63**	**422**	**7%**
Shrub and chaparral							
CX	Upper Montane Mixed Chaparral	65	37	39	222	362	6
Subtotal shrub and chaparral		**65**	**37**	**39**	**222**	**362**	**6%**
Total All Alliances		**2918**	**1305**	**694**	**1075**	**5992**	**100%**
Percentage by severity class		**49%**	**22%**	**11%**	**18%**	**100%**	

*The severity data is remotely sensed, using the RAVG process. Acreage differences between the RAVG data and fire perimeter GIS acreage are due to differences in the way data is obtained, and polygon acres versus raster data acres

Summary of Vegetation Fire Severity for Recent Wildland Fires

GIS analysis of existing vegetation fire severity layers for the Megram and Backbone fires reveals that approximately 1,208 acres that burned at high severity during the Megram Fire re-burned in the Backbone Fire ten years later. Vegetation in the 1,208 acres of re-burn area included only 65 acres of regional dominance types comprised of shrubs, while 1,144 acres included regional dominance types that are considered productive forest lands. Of these 1,144 acres, the overstory tree diameter and tree cover from above on 1,091 acres (90 percent of the re-burn area) was considered ‘non-stocked’ (N) with less than ten percent cover (code 01). High vegetation fire severity in the Backbone Fire occurred predominantly on southwest aspects.

The interpretation of this analysis is that the Backbone Fire burned at higher intensities and produced higher vegetation fire severity in areas that burned at high intensity during the Megram Fire. Shallow soil depths, low soil moistures and solar radiation may have further contributed to high fire severities. Cover representations (less than 10 percent stocked) in high vegetation fire severity areas are not necessarily a result of past fires, but could rather be a product of environmental factors such as aspect. South and southwest aspects generally have less vegetation cover than north and northwest aspects.

Review of the above tables reveals that vegetation fire severity effects in the moderate and high categories were greater in the Backbone Fire than in the Iron-Alps, Corral and River Complexes. Many factors may have influenced vegetation fire severity, including weather, topography and pre-fire fuels and vegetation conditions, among others.

Table 24 below summarizes the average acres and percentages of vegetation fire severity classes for all recent fires. Unchanged and low-severity acres account for approximately sixty-one percent of the fire area within the project area. Moderate (mixed) severity accounts for another fifteen percent. High severity fires account for the remaining twenty-seven percent of the project area.

Table 24. Vegetation fire severity classes summarized for Iron Alps Complex, Backbone Fire, Corral Complex and River Complex within the project boundary

Vegetation Fire Severity Classes	Brief description	Acres of fire perimeters affected	Percentage fire perimeters affected
Unchanged	One year after the fire was indistinguishable from pre-fire conditions.	6,827	44%
Low	Little change in cover and little mortality of the structurally dominant vegetation.	3,470	22%
Moderate	Mixture of effects on the structurally dominant vegetation	2,092	13%
High	Dominant vegetation has high to complete mortality	3,292	21%

* Together, these fires affected 15,681 acres within the project area, however some include overlap within recent fire activity.

Of significance is that overall moderate- and high-severity fire acres were greatest in the Backbone Fire. Of the high-severity acres in the Backbone Fire, the Conifer Forest/Woodland category had the most acres affected (1,679 acres). Approximately 1,443 acres were unchanged.

Environmental Consequences

Analysis Methodology

Assumptions

The No Action alternative assumes wildland fire under uncontrolled conditions. Under no action, effects to vegetation were discussed assuming that a future wildland fire would occur during the May-October fire season typical for the area.

Under the action alternatives, it was assumed that prescribed fire would be ignited when predicted weather and fuel moisture would be conducive to mostly low-intensity fire to minimize moderate- and high-severity vegetation effects. Prescriptive versus unplanned wildland fire generally results in favorable overall effects to vegetation. The outcomes of prescribed fire have desirable consequences as fuels are removed during combustion under controlled conditions. Prescriptive fire is utilized to remove fuels and avoided when the expected effects to vegetation are considered unacceptable. The overall goal of prescribed fire is to provide a net (positive) benefit to vegetation by removing excess fuels. Excess fuels generally result in a detrimental loss of vegetation in unplanned fire events. Fires used under prescription conditions assist land managers in maintaining overall vegetation cover.

For the purposes of analysis, recent wildland fires (specifically Backbone Fire and Iron Alps Complex) provide a reference for discussing the potential effects of the alternatives on future fire behavior and resulting effects to vegetation.

The timing of burning is likely to influence the vegetation fire severity effects of prescribed fire. For example, studies show that in the western United States, prescribed fires ignited in the spring when large diameter fuel moisture is higher are likely to achieve less than full consumption of these larger fuels and therefore release less heat[85] than during a typical wildfire season (May through October). Prescribed fires ignited in the fall under similar fuel moisture conditions would be expected to have similar effects to vegetation.

Either action alternative could theoretically be implemented at any time of year – notwithstanding limited operating periods for wildlife and other factors. However, prescribed fire would only be ignited under fuel moisture conditions and predicted weather conducive to safely reducing fuel accumulations while minimizing adverse effects to other resources, including vegetation (see Fire and Fuels discussion above).

Comparison of Alternatives

Direct and Indirect Effects Analysis

Vegetation fire severity from recent wildfires was analyzed to compare the potential effects of the alternatives with regard to vegetation fire severity in a future wildfire. Vegetation fire severity in those fires was derived from RAVG GIS data (see the methodology for vegetation fire severity in the Existing Conditions section above). The Megram Fire of 1999 burned almost the entire project area at varying vegetation fire

[85] Knapp et al. 2009, p. 1

severities (see table 25 below). Subsequent fires (Iron Alps Complex of 2008 and the Backbone Fire of 2009) re-burned areas burned in the Megram Fire. The vegetation fire severities resulting from these recent fires provide a context for comparing predicted severities from no action to prescribed fire as proposed under the action alternatives. Areas that experience moderate and high vegetation fire severities in wildland fires are likely to have increased fuel loading, particularly of large diameter trees killed from crown fire. In addition, areas that burn at low severity would likely kill but not consume small diameter trees and understory shrubs. Miller et al.[86] hypothesized that small-diameter trees and understory shrubs that are killed but not consumed in the first low-severity fire become dried, and if a second fire enters the same area before the dead fuels decompose, these fuels could contribute to higher intensities than would otherwise occur. Fuel moisture conditions and predicted weather at the time of ignition would affect fire intensities.

Cumulative Effects Analysis

The cumulative effects analysis area for analyzing the effects of the alternatives on vegetation composition and vegetation fire severity is the project area. The predicted effects of the alternatives beyond the project area boundaries may include changes in the risk of fire entering or exiting the project area; however, the resulting effects to vegetation beyond the project area cannot be discussed in a meaningful manner because of multiple and often unknown variables that could also affect vegetation outside the project area.

The time period for measuring cumulative effects is approximately twenty years after completion of project activities or, if the No Action alternative is selected, twenty years from the date of the decision. Twenty years is the predicted duration of effectiveness of the fuels treatments in modifying future fire behavior (see the Fire and Fuels section above).

Features Common to Both Action Alternatives

1. The timing and location of ignitions affect fire intensity, which in turn can influence fire effects to vegetation. Prescribed burning would be conducted under conditions that are favorable to objectives set forth in this analysis. The season and prescriptive level burning practices would be identified in the project burn plan that would be prepared if an action alternative is selected.
2. The felling of danger trees (live or dead) during project implementation is expected to be an uncommon occurrence. Any trees identified as danger trees would be avoided where possible. Those that cannot be avoided would be neutralized in a manner consistent with Minimum Impact Suppression Tactics (MIST).
    a. Where possible, danger trees would be blasted to avoid the unnatural appearance of stumps. See the project file for a description and illustration of this method, which is the preferred treatment for danger trees in wilderness areas.

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[86] Miller et al. 2009

b. Where blasting is not possible or is considered unsafe, danger trees would be cut with stumps as close to the ground as possible; stumps would then be covered with on-site vegetation or other materials. Trees would be felled using hand saws unless it is determined on a site-specific basis that use of chainsaws is necessary for safety reasons.

Alternative 1

Direct and Indirect Effects

Under the No Action alternative, no prescribed fire treatments would be conducted. Current management practices with regard to fire, fuels and vegetation would continue. No direct effects to vegetation would occur.

Indirectly, the percentages of vegetation fire severity displayed in table 25 below could be anticipated for the landscape effects of a future wildland fire, provided the fire is not contained. These percentages were applied to display the predicted landscape level effects of an unplanned ignition across the project area. The likelihood of a wildland fire is assessed by risk over time. Approximately 49,130 acres[87] (eighty-four percent) of the project area burned in the Megram Fire. Vegetation fire severity for the Megram Fire within the project area is summarized in table 25 below.

Table 25. Vegetation fire severity resulting from the Megram Fire*

Vegetation Fire Severity Class	Acres	Percentage of project area
Unchanged	10,620	22%
Low	19,051	39%
Moderate	8,674	18%
High	10,785	22%
Total	**49,130**	**100%**

* Vegetation fire severity data from the Shasta Trinity National Forest GIS library, pre RAVG.

The Megram Fire is significant in understanding landscape level effects as a result of future unplanned ignitions that are likely to result in wildland fires. If an unplanned ignition starts during fire season, which is typically May through October, the resistance to control is likely to be increased by the high level of available fuels resulting from the Megram Fire. Subsequent fires have contributed to fuel accumulations due to additional vegetation mortality.

Previous wildland fires within the project area have the potential to contribute significant fuels as a result of low, moderate and high vegetation fire severity effects. It is unknown exactly when or how a wildland fire will occur, but if one does occur in the project area, effects as displayed above in table 25 for the Megram Fire, or below in table 26 for the Backbone Fire, would be the predicted vegetation fire severity under the No Action alternative in the event of an unplanned ignition.

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[87] From 2011 FRAP GIS data

Table 26. Predicted vegetation fire severity under the No Action alternative in the event of an unplanned ignition*

Vegetation Fire Severity Classes	Brief description	Acres within the project area likely to be affected	Percentage of the project area likely to be affected
Unchanged	One year after the fire was indistinguishable from pre-fire conditions.	22,172	38%
Low	Little change in cover and little mortality of the structurally dominant vegetation.	13,420	23%
Moderate	Mixture of effects on the structurally dominant vegetation	8,752	15%
High	Dominant vegetation has high to complete mortality	15,754	27%

* Acres are derived from vegetation fire severity percentages within the project area during the recent Backbone Fire. The Backbone fire is used as an example of wildfire behavior burning in the footprint of a previous wildfire (i.e., Megram Fire) and which is the result of an unplanned/natural ignition during a typical fire season.

The numbers represented above are anecdotal, as the true effects of a wildland fire are unknown until it occurs. Location and timing of ignition and seasonality affect the severity effects to vegetation during fires. The above numbers are loosely based on regional dominance types in the project area and their similarity on the landscape to those affected in recent wildland fires. With the predominant vegetation type in the project area being forested, and predominant acres affected during recent wildland fires being forested, the effects of a future wildfire across the landscape can be assumed to be similar to that of previous fires if the proposed fuels treatments are not implemented. Repeated high severity fires (estimated 27% of project area above) resulting in high to complete mortality reduces or removes the available conifer seed sources needed for natural regeneration. This will ultimately result in a type conversion from forested land to early seral shrub-dominated lands due to lack of available seed source.

Cumulative Effects

Cumulatively, the No Action alternative is likely to result in higher vegetation fire severities in the event of a future wildland fire. This would be expected due to continued fuels accumulation and increasing vegetation densities over time. For example, vegetation fire severity effects such as those that occurred in portions of the Iron-Alps Complex fires (refer back to Table 20) are similar to those that might be expected in a prescribed fire, despite occurring during fire season and utilizing intensive suppression techniques. However, the residual fuels from the Iron-Alps Complex in combination with accumulated untreated fuels from subsequent fires would increase the occurrence of moderate- and high-severity fires.

Dynamic forested ecosystems are disturbance-dependent, and past wildland fire suppression policies have removed the major disturbance regime - frequent, mixed-intensity fires – that were once common to the project area. A course of no action, in combination with ongoing fire suppression, would continue the trend away from historical fire frequency, intensity and vegetation fire severities.

Alternative 2 – Proposed Action

Direct Effects

Approximately 16,709 acres would be treated under this alternative. Prescribed fires are ignited to burn vegetation under controlled, pre-defined conditions, when specific weather, moisture and other environmental conditions exist. Prescribed fire conditions are anticipated to result in vegetation fire effects for the majority of the treatment areas in the severity classes of 'unchanged', 'low' and occasionally 'moderate.' High- severity vegetation effects may occur in a few small, isolated patches. The project-specific burn plan addresses the level of acceptable mortality, or general percentage of high-severity fires that would be acceptable[88]. Prescribed fire vegetation fire severities would be predicted to maintain compliance with applicable laws, policy, management direction and project design features.

Table 27 below displays the maximum predicted vegetation fire severities within the proposed treatment areas from prescribed fire under Alternative 2. The vegetation fire severity percentages are derived from vegetation fire severities from the recent Iron-Alps Complex. These percentages are likely within the range of historic norms for all severity levels and display what would be considered a mixed-severity fire. It should be noted that the Iron-Alps Complex burned under weather and fuels conditions of between the 60th and 90th percentiles[89] over several months. Prescribed fires under controlled conditions (i.e., under conditions between the 30th to 60th percentiles) are likely to burn at somewhat lower intensities, with a lower percentage of resulting high vegetation fire severity.

[88] Severity class description from the RAVG categorization was used to predict the effects of prescribed fire.
[89] see Appendix A - Glossary

Table 27. Predicted vegetation fire severities from prescribed fire in proposed treatment areas under Alternative 2

Vegetation Fire Severity Classes	Brief description	Acres within the treatment areas likely to be affected	Severity percentage applied to each severity class
Unchanged	One year after the fire was indistinguishable from pre-fire conditions.	7,519	45%
Low	Little change in cover and little mortality of the structurally dominant vegetation.	5,012	30%
Moderate	Mixture of effects on the structurally dominant vegetation	2,506	15%
High*	Dominant vegetation has high to complete mortality	1,670	10%

* Vegetation fire severity percentages are derived from the recent Iron-Alps Complex, which burned during fuel and weather conditions of between the 60th and 90th percentiles. Actual high vegetation fire severities resulting from prescribed fire under 30th to 60th percentile conditions would likely be less than 10 percent.

**While similar, note that these percentages describe different classifications of predicted effects than those displayed in Table 13which are based on burn probabilities, predicted flame lengths, and crown fire potential within the project area.

Alternative 3 – Additional Treatment Acres

Direct Effects

Alternative 3 proposes to treat approximately 2,379 acres in addition to the treatments proposed under Alternative 2. Prescribed fire techniques would be the same; the only difference is that more acres would be treated. Approximately 19,088 acres would be treated under this alternative.

Table 28 below displays the maximum predicted vegetation fire severities from prescribed fire within the proposed treatment areas under Alternative 3. The same percentages of vegetation fire severity described above for Alternative 2 were used. The only change is to the acres potentially affected, as Alternative 3 would treat more acres than Alternative 2. As with Alternative 2, prescribed fires under controlled conditions are likely to burn at somewhat lower intensities, with a lower percentage of resulting high vegetation fire severity.

Table 28. Predicted vegetation fire severities from prescribed fire in proposed treatment areas under Alternative 3

Vegetation Fire Severity Classes	Brief description	Acres within the treatment areas likely to be affected	Severity percentage applied to each severity class
Unchanged	One year after the fire was indistinguishable from pre-fire conditions.	8,589	45%
Low	Little change in cover and little mortality of the structurally dominant vegetation.	5,726	30%
Moderate	Mixture of effects on the structurally dominant vegetation	2,863	15%
High*	Dominant vegetation has high to complete mortality	1,908	10%

* Vegetation fire severity percentages are derived from the recent Iron-Alps Complex, which burned during fuel and weather conditions of between the 60th and 90th percentiles. Actual high vegetation fire severities resulting from prescribed fire under 30th to 60th percentile conditions would likely be less than 10 percent.

Effects Common to Both Action Alternatives

Alternatives 2 and 3 would implement prescribed fire utilizing a project-specific burn plan. While the two action alternatives would treat different acreages, the qualitative discussion of the predicted effects applies to both.

Direct and Indirect Effects

With regard to direct effects, Conifer Forest/Woodland category acres would receive the most prescribed fire treatment under both action alternatives, as this category of vegetation encompasses most of the project area.

The overall effects to stand structure would vary depending on existing conditions and intensity of burn. In general, fuel loading would be reduced as the finer surface fuels are consumed by fire, leaving much of the large woody debris, or creating cavities within. The suppressed and/or intermediate cohort of the stand are most likely to experience some degree of mortality due to the presence of foliage within flame length of the ground (ladder fuels), increasing the number of small diameter snags within the stand (which will eventually contribute to surface fuels in three to ten years). While most of the codominant/dominant trees and mature stand characteristics would remain intact, small pockets of mortality can be expected as fire occasionally moves into the crown, resulting in a mosaic of structural diversity across the landscape.

Tree response to fire may vary depending on factors such as species, size, season of burn, and the amount and rate of fuel consumption. For example, one prescribed burn study found that ponderosa pine, white fir and incense cedar had low mortality rates even with a high volume of crown scorch, while sugar pine and white fir were less fire -tolerant[90]. Douglas-fir has also shown high fire tolerance due in part to its thick bark[91]. Species such as grey pine would directly benefit from low to moderate intensity prescribed fire due to the increased seed germination rates due to the heat scarification of the woody seedcoat. Knobcone pine trees may be killed by moderate to high intensity fire; however, the cones are serotinous (i.e., requiring heat to open and release the seeds), which enables rapid recolonization via sexual rather than vegetative reproduction.

Most hardwood tree and shrub species found in the project area would be expected to resprout (via the root crown, lignotubers, rhizomes, or stump-sprouting) following a low- to moderate-severity fire.[92] Higher-intensity fire patches can result in complete plant mortality, rendering the affected plants unable to resprout; however, only about one percent of the proposed treatment area is modeled for this level of intensity[93]. Additionally, a low- to moderate-intensity fire may increase seed germination through scarification (e.g. greenleaf or pinemat manzanita, whitethorn ceanothus); however, even this level of fire intensity may kill seeds of other species (e.g. black oak, Fremont silktassel, bittercherry, salal, canyon live oak and Oregon white oak).[94] Seeds buried deeper beneath the duff or topsoil layer may be protected from fire damage unless a high-intensity ground fire occurs.

Direct effects to vegetation may be more acute in the event of a spring (post bud-break) burn due to the scorching of buds or other reproductive structures, or the damaging of tissues during a time when: 1) carbohydrate reserves necessary to sustain growth are often at their lowest levels and 2) the tender early-season tissues may be more sensitive to heat.[95]

Due to the small percentage of the project area modeled for high-severity patches (see tables 27 and 28 above with the comments for high vegetation fire severity), it is likely that direct adverse effects (e.g. basal area mortality) would be minor and direct positive effects (e.g. seed scarification) would be moderate. As such, small patches of mortality as would be expected under low to moderate burn severity would maintain existing species composition, especially in mature trees contributing to complex forest structure and not lead to a type conversion away from forested conditions that could be expected with repeated, large high severity fires.

Indirectly, because reducing fuels through prescribed fire would provide less combustible material (both surface and ladder fuels) to carry a future wildfire, either action alternative would be expected to moderate vegetation fire severities in future wildland fire events in the areas treated. In addition, prescribed fire placed strategically on the landscape, as

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[90] Stephens and Finney 2002
[91] Fire Effects Information System 2011
[92] Ibid.
[93] Less than one percent of the hardwood/woodland alliance is anticipated to burn at moderate to high intensity (see Table 20)
[94] Ibid.
[95] Knapp et al. 2009

designed under both action alternatives, may modify future fire behavior and moderate vegetation fire severities in portions of the project area not treated (see the Fire and Fuels section).

Cumulative Effects

The cumulative effects under both action alternatives are anticipated to include a trend to historical vegetation fire severities in the project area, with a decrease in high- and moderate-severity effects from what has occurred in recent fires, given that current fire management policies in the Trinity Alps Wilderness are likely to continue. As prescribed fires with low to moderate-severity effects will maintain mature forested conditions and species composition better than moderate to high-severity effects anticipated with natural late-summer/early fall ignitions, the project is likely to contribute to and enhance long-term maintenance of the vegetative character within the project area. No adverse cumulative effects to vegetation are anticipated from implementation of either action alternative.

Compliance with the Forest Plan and Other Regulatory Direction

All alternatives would meet current forest plan direction and other policy and laws with regard to fire and fuels, vegetation and air quality, as demonstrated below.

Fire and Fuels

As determined above, implementation of prescribed fire under either action alternative, with incorporation of the proposed design features, would reduce the risk of adverse effects from wildfire to resources of concern in the project area. In addition, the proposed activities would trend fuel conditions and vegetation composition and structure toward historic norms. Both action alternatives would therefore meet current policy, law and direction. The No Action alternative would also meet current policy, law and forest plan direction, at least in the short term. The occurrence of a large, severe wildfire, however, could result in the project area not meeting current direction.

Air Quality

Based on the above analysis, and with design features described to reduce emissions from prescribed fire, both action alternatives would comply with the federal Clean Air Act and Regional Haze program regulations. The No Action alternative would also meet the requirements set forth in these regulations, except in the event of a large, severe wildfire.

Vegetation

Implementation of prescribed fire under either action alternative would reduce the risk of adverse effects from wildfire to resources of concern in the project area. Vegetation fire-severity effects from prescribed fire under both action alternatives would be expected to be less than with a wildfire, as prescribed fires would be ignited under prescriptive conditions. In addition, the proposed activities would trend vegetation composition and vegetation fire severity toward historic norms. Both action alternatives would meet current policy, law and direction. The No Action alternative would also meet current policy, law and forest plan direction in the short term. However, wildland fire risk and fire hazard would increase as untreated fuels continue to accumulate. In the event of a large, severe wildfire, the likely result would be higher vegetation fire severity, as a wildfire is likely to occur under more extreme conditions.

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Appendix A -- Glossary

90th Percentile Weather Conditions - the highest 10 percent of fire weather days; where, fuel moisture, temperature, relative humidity, and wind speed are only exceeded 10 percent of the time based on historical period of weather observations.

Aerial ignition – method of igniting a prescribed fire that entails the use of aerial equipment such as helicopters equipped with an ignition device. Aerial ignition, if done properly, enhances safety, mitigates hazards associated with ground ignition, and reduces the number of personnel exposed to risk.

Anadromous fish bearing streams – streams that support fish species that return from the ocean to reproduce.

Backing fire – a segment of fire perimeter oriented opposite the direction of maximum spread. The rate of spread and fireline intensity is usually low.

Burn plan (prescribed burn unit plan) – a field document, required for all prescribed burning activities, that sets forth the details for conducting a site-specific burn treatment. The prescribed burn plan details the prescription parameters and professional standards to be utilized in conducting the burn.

Burn probability modeling – a modeling method that simulates the effect of the ignition and spread of a very large number of fires on a raster landscape to calculate spatially explicit outputs (i.e., likelihood of ignition) on a landscape level; model used to calculate **burn probabilities** on a given landscape.

California Air Resources Board (CARB) – a department in the California Environmental Protection Agency established in 1967 in the Mulford-Carrell Act, combining the Bureau of Air Sanitation and the Motor Vehicle Pollution Control. The stated goals include attaining and maintaining healthy air quality, protecting the public from exposure to toxic air contaminants; and providing innovative approaches for complying with air pollution rules and regulations

Communities at risk – identified communities within the WUI at high risk to wildfire, listed, published and maintained in the state of California by the California Fire Alliance. The National Fire Plan directs funding to be provided for projects designed to reduce the fire risk to communities.

Confine- A strategy employed in appropriate suppression responses where a fire perimeter is managed by a combination of direct and indirect actions, and use of natural topographic features, fuel, and weather factors.

Contained- The status of a wildfire suppression action signifying that a control line has been completed around the fire, and any associated spot fires, which can reasonably be expected to stop the fire’s spread.

Controlled- The completion of control line around a fire, any spot fires therefrom, and any interior islands to be saved; burned out any unburned area adjacent to the fire side of the control lines; and cool down all hot spots that are immediate threats to the control line, until the lines can reasonably be expected to hold under the foreseeable conditions.

Crown fire – a fire burning in the crowns of forest vegetation; can be passive, active, or independent.

Cumulative watershed effects - environmental changes that are affected by more than one land-use activity and that are influenced by processes involving the generation or transport of water. Almost all environmental changes are cumulative effects, and almost all land-use activities contribute to cumulative effects. Cumulative effects first must be evaluated to decide what actions are appropriate. The likely direct and indirect effects of the planned actions must then be assessed.

Direct fire suppression (direct attack) – any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel. This includes the work of urban and wildland fire engines, fire personnel and aircraft applying water or fire retardant directly to the burning fuel. For most agencies, the objective is to construct a fireline around all fire meant to be suppressed.

Fire intensity - the heat released per unit of time for each unit length of the leading fire edge; the primary unit is BTU per lineal foot of fire front per second (sometimes referred to as fireline intensity).

Fire regime - the long-term fire pattern characteristics of an ecosystem described as a combination of seasonality, frequency, spatial complexity, intensity, duration and scale.

Fire return interval – the length of time between fires on a particular landscape.

Fire severity - a qualitative assessment of the heat pulse directed toward the ground during a fire. Fire severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of below-ground plant parts (see Vegetation Fire Severity below).

First-order fire effects- occur during and immediately after a fire and are primarily heat-induced chemical processes. Reinhardt and others (2001), describe first-order effects to occur at the time of fire or within seconds or minutes afterward.

Flame length – the average distance from the base of the flame to its highest point. Flame length is the only measurement that can be taken easily in the field that is related to fireline intensity. **Fuel Loading-** Describes the amount of dead and down fuels laying on the ground surface in tons per acre.

Hand lighting methods – means of igniting a prescribed fire that involve ground personnel using fire ignition tools, generally a drip torch filled with approved burn mix, which requires the personnel to manually walk in the prescribed burn area to light the fire.

Hazard tree (Danger Tree) – a standing tree that presents a hazard to people due to conditions such as, but not limited to, deterioration or physical damage to the root system, trunk, stem, or limbs and the direction or lean of the tree.

Ignition pattern – a predetermined method of lighting a prescribed fire that considers topography, location, geography, slope position and vegetation to achieve the desired results of the prescribed fire effects and enhance the ability to control the burn.

Indirect fire suppression (indirect attack) - preparatory suppression tactics used a distance away from the oncoming fire are considered indirect. Firelines may be built in this manner as well. Fuel reduction, indirect firelines, contingency firelines, backburning and wetting unburned fuels are examples. This method may allow for more effective planning. It may allow for more ideally placed firelines in lighter fuels using natural barriers and for safer firefighter working conditions in less smoke filled and cooler areas. However, it may also allow for more burned acreage, larger and hotter fires, and the possibility of wasted time constructing unused firelines.

Limited Operating Periods (LOP) – a period when vegetation treatments are restrained due to issues of concern, generally wildlife nesting season for species of concern.

Longline (helicopter) – use of a fixed rope attached to a helicopter to transport cargo and supplies.

Lop and scatter – a method of slash disposal that involves cutting (lop) and dispersal (scatter) of slash to designated specifications.

Minimum Impact Suppression Techniques (MIST) –wildland firefighting techniques that involve use of the minimum amount of force necessary to effectively achieve the fire management protection objectives consistent with land and resource management objectives. Methods used to suppress a wildfire while minimizing the long-term effects of the suppression action on the land. MIST may include rehabilitation of constructed firelines and other evidence of suppression efforts.

Prescribed fire –a fire treatment to meet one or more specific management objectives. Prescribed fires follow site-specific documents directing their preparation, administration and implementation.

Pruning – removal of branch material from the bole of a living tree. The effect of pruning is to raise crown base height so that there are discontinuous fuels from the forest floor to the crown of the living trees.

RAVG GIS – Rapid Assessment of Vegetation Condition after Wildfire (RAVG) analysis looks at fires that have burned more than one thousand acres of National Forest System (NFS) forested lands. RAVG products (including GIS data) are produced at the Remote

Sensing Applications Center (RSAC) to provide information that can assist post-fire vegetation management planning designed to address a number of management objectives.

Vegetation Fire Severity - a qualitative assessment of the primary and secondary effects of fire on vegetation resulting from site characteristics and fire behavior such as fuel loading, fuel moisture, soil moisture, seasonality, flame length, and fire intensity. Vegetation fire severity is ranked as low, moderate or high, and reflects the percentage of basal area reduction from fire. Vegetation-based fire severity[96] is described as follows:

Unchanged = no visible fire effects

Low = l0-25 % mortality

Moderate = 26 to 75% mortality

High = greater than 75%

Watershed - the entire land area that drains to a specific point. Watersheds are usually delineated by Hydrologic Unit Codes (HUC). For example:

A 5th field watershed (5th field HUC) ranges from about 40,000 to 250, 000 acres in size.

A 6th field watershed (6th field HUC) ranges from about 10,000 to 40,000 acres in size.

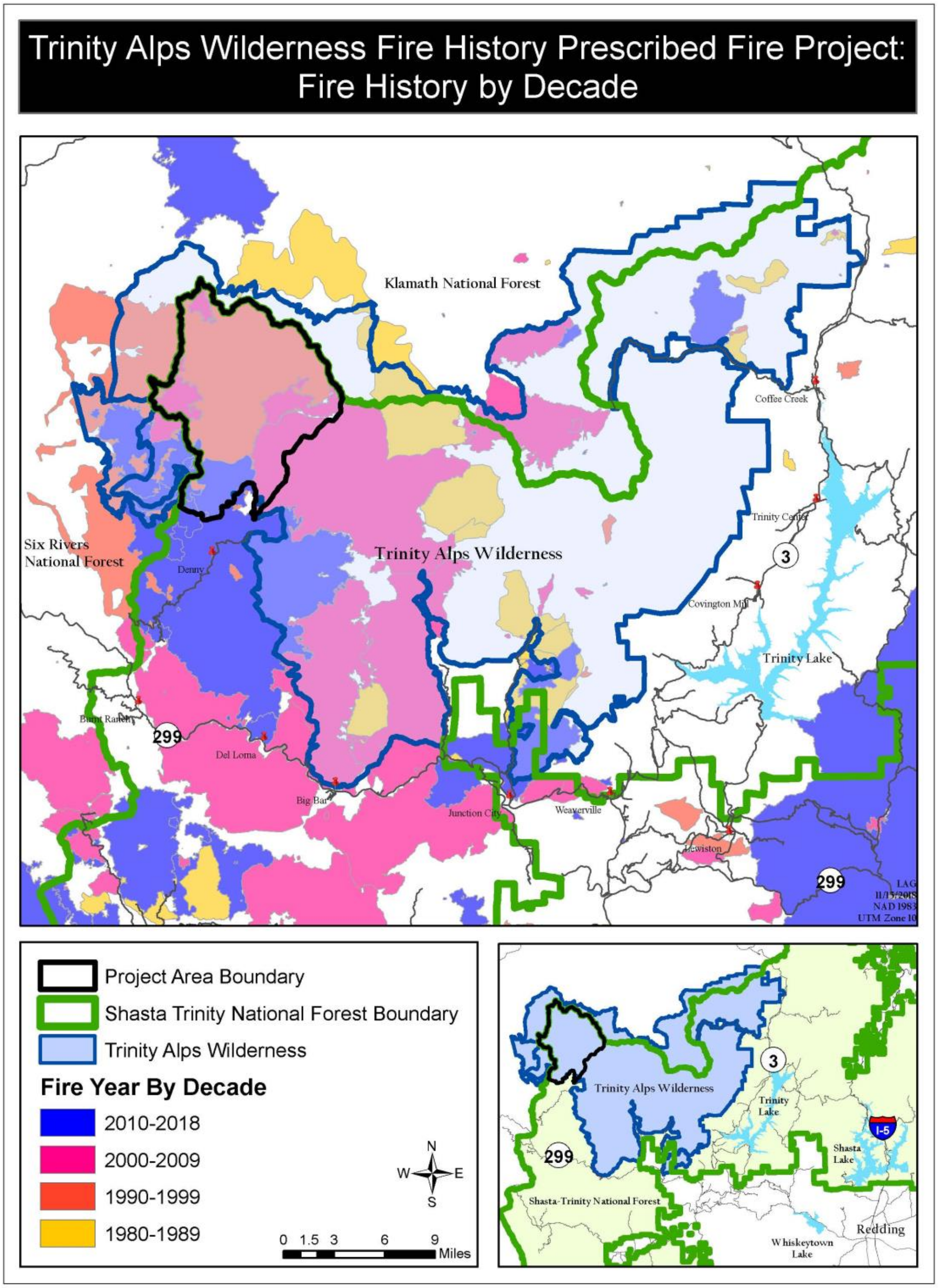
A 7th field watershed (7th field HUC) ranges from about 2,500 to 10,000 acres in size.

See http://pubs.usgs.gov/wsp/wsp2294/ for more information.

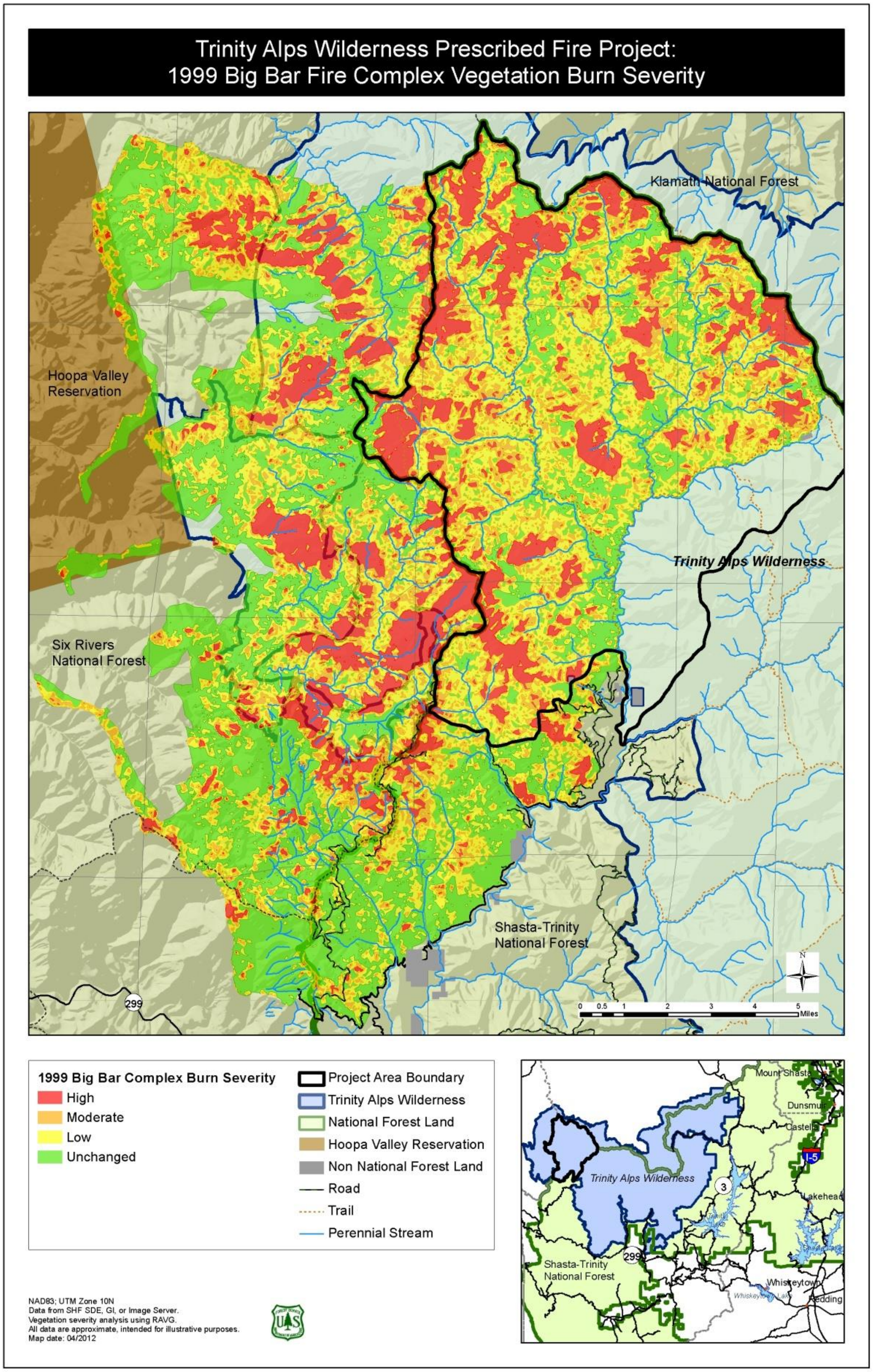
Wildland urban interface (WUI) – the area where human development and structures (urban) intermingle with undeveloped areas (wildland).

[96] Miller et al. 2009

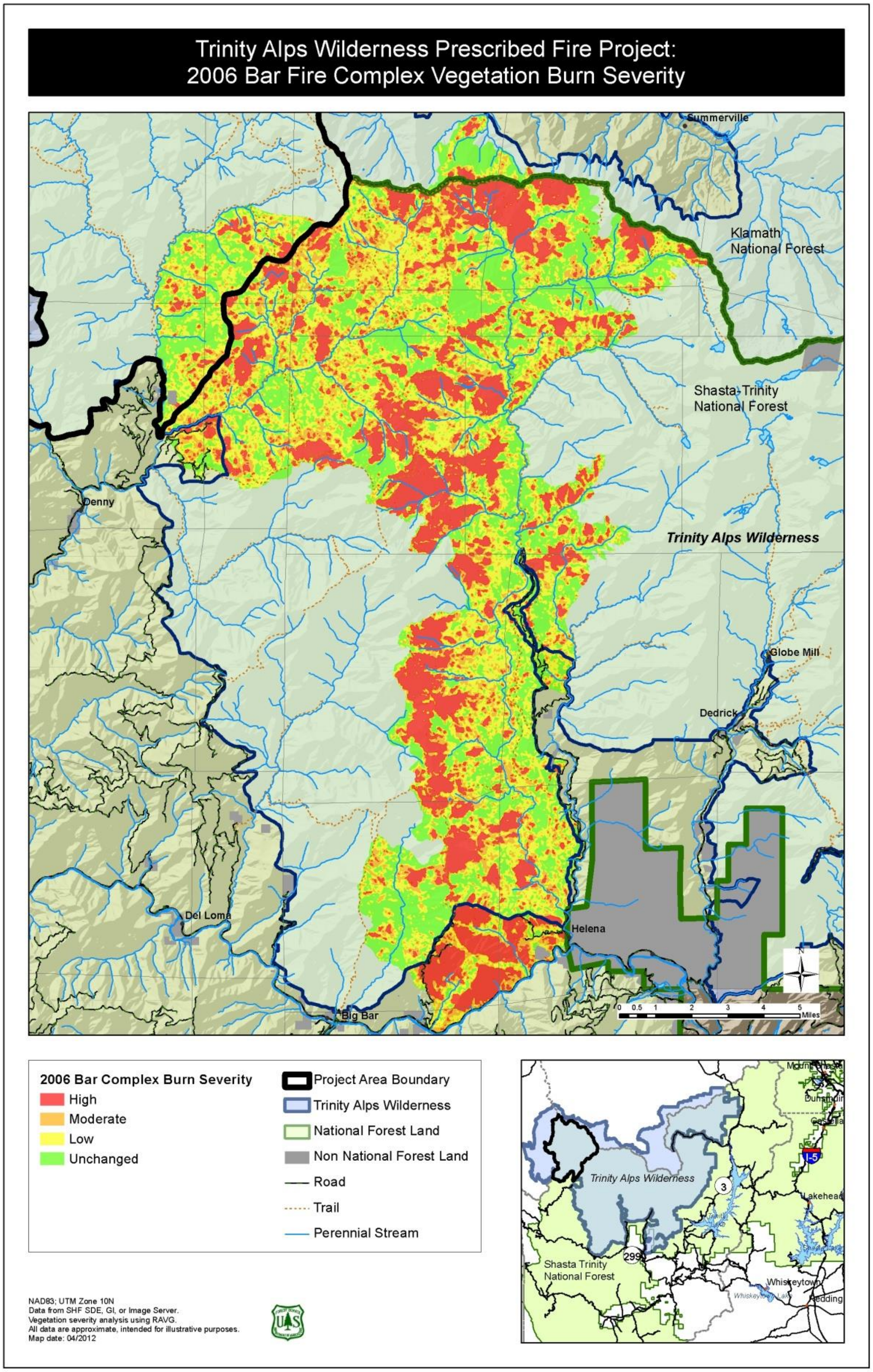
Appendix B – Maps



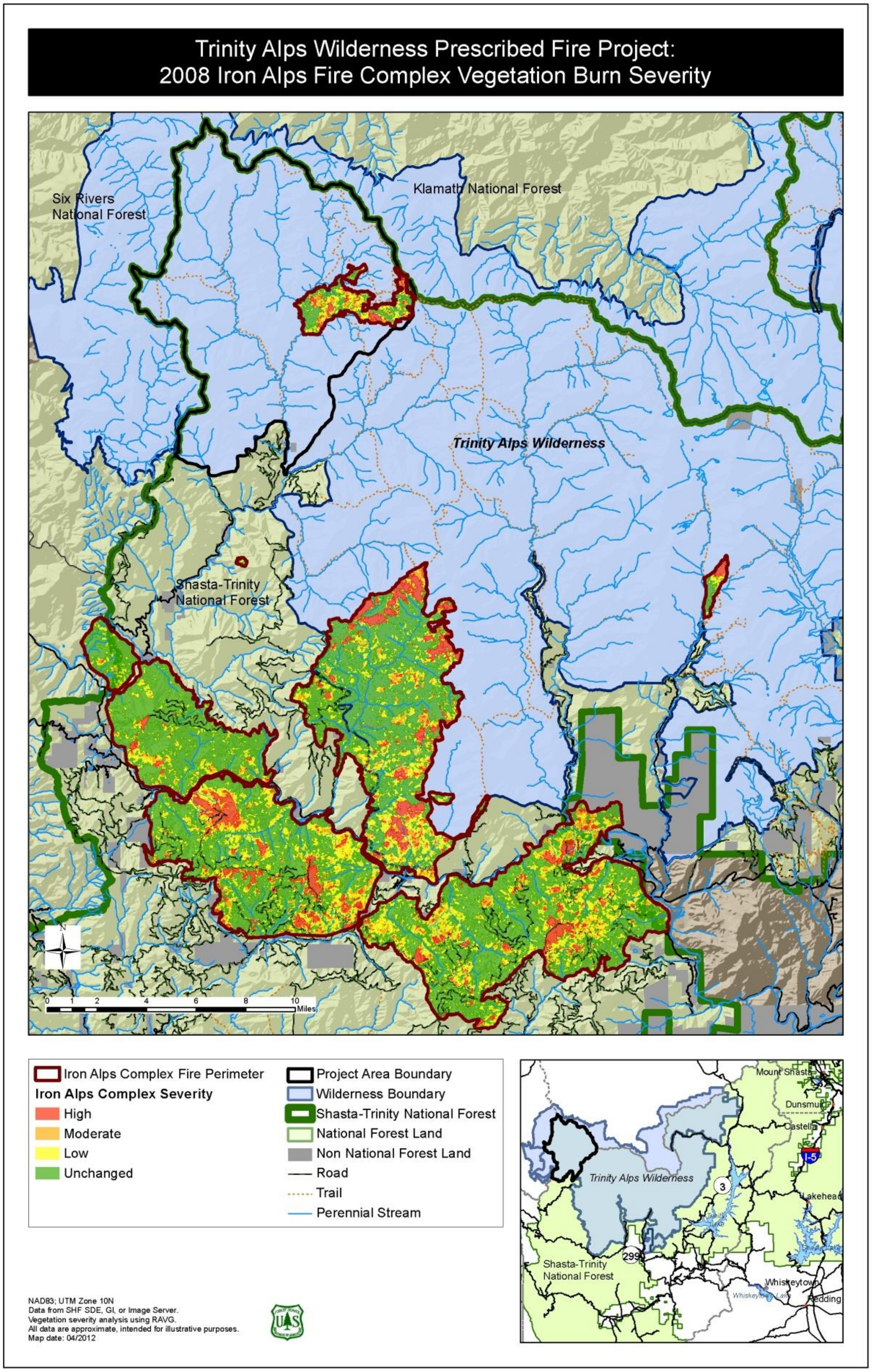
Map 1. Large fire history in the Trinity Alps Wilderness, by decade



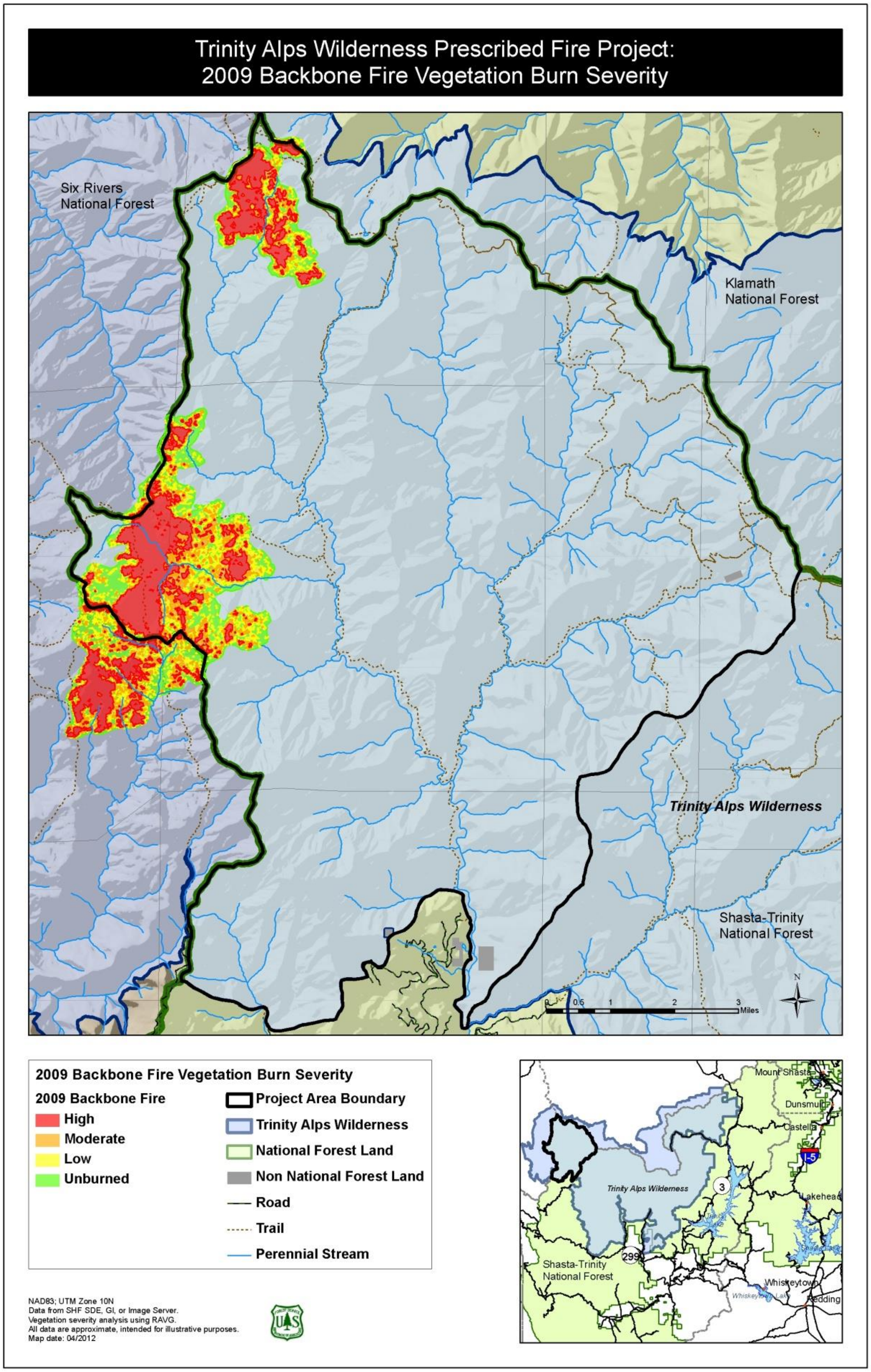
Map 2. Vegetation fire severities during the 1999 Big Bar Complex, Trinity Alps Wilderness



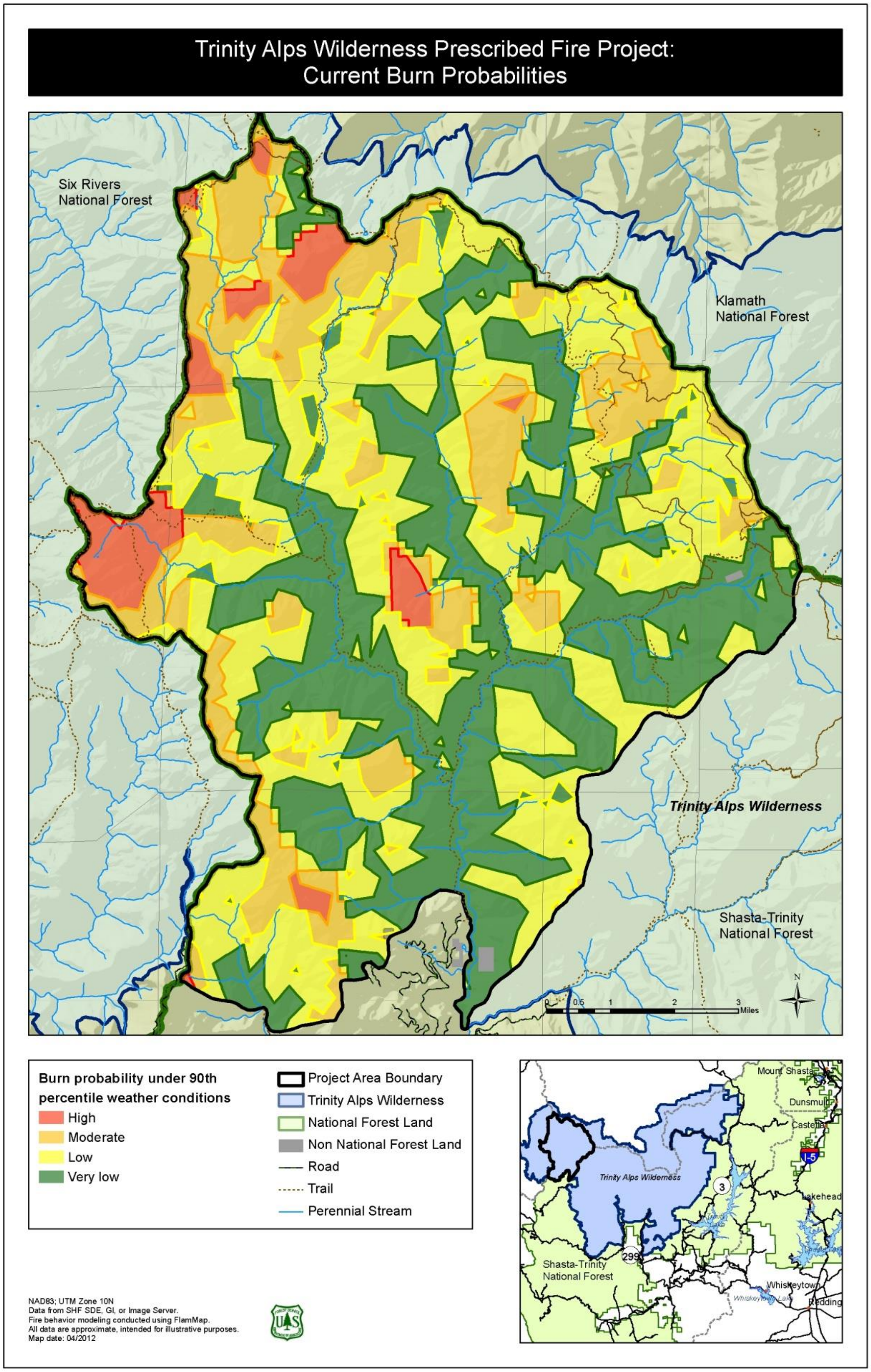
Map 3. Vegetation fire severities during the 2006 Bar Complex, Trinity Alps Wilderness



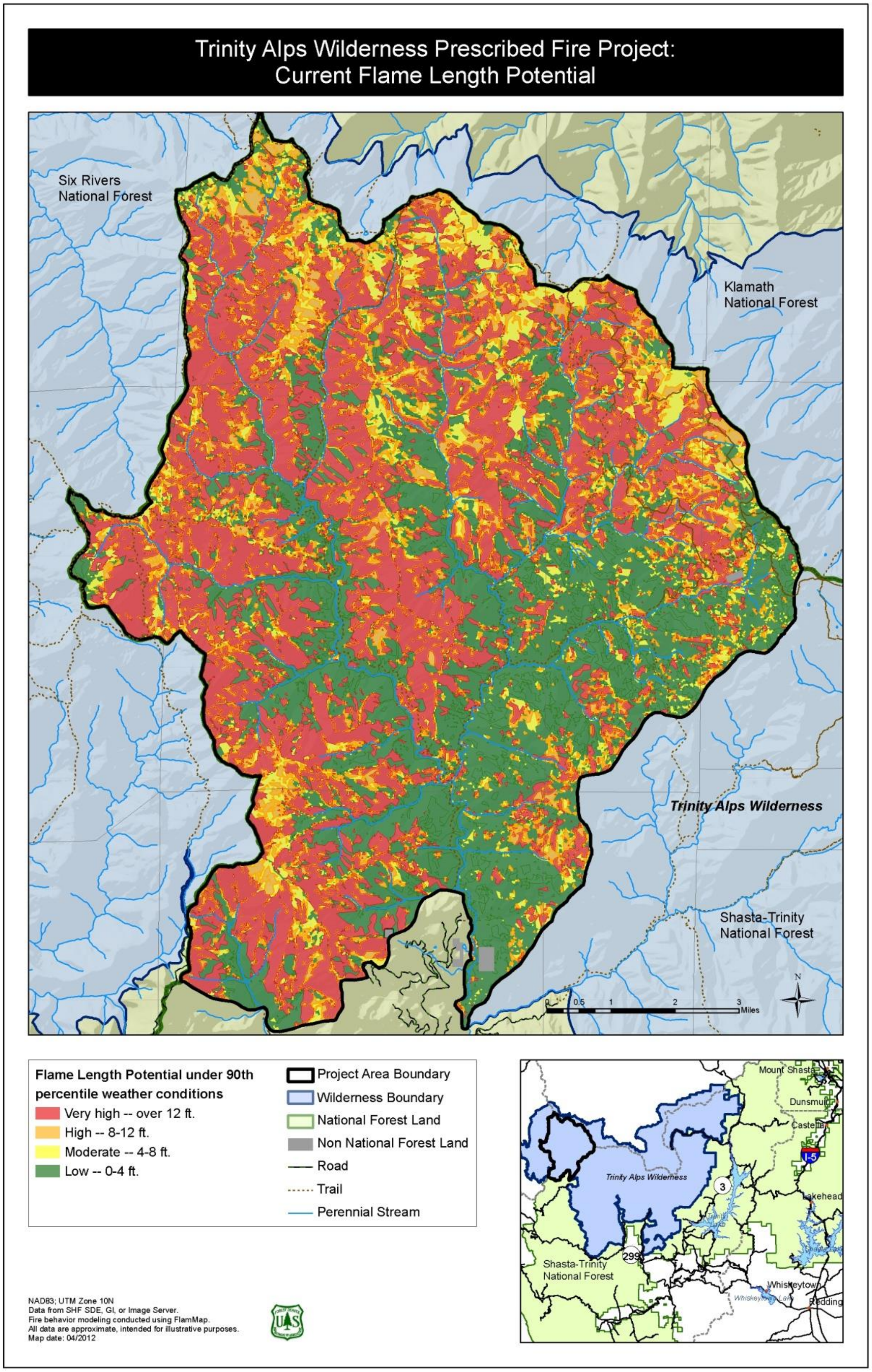
Map 4. Vegetation fire severities during the 2008 Iron/Alps Complex, Trinity Alps Wilderness



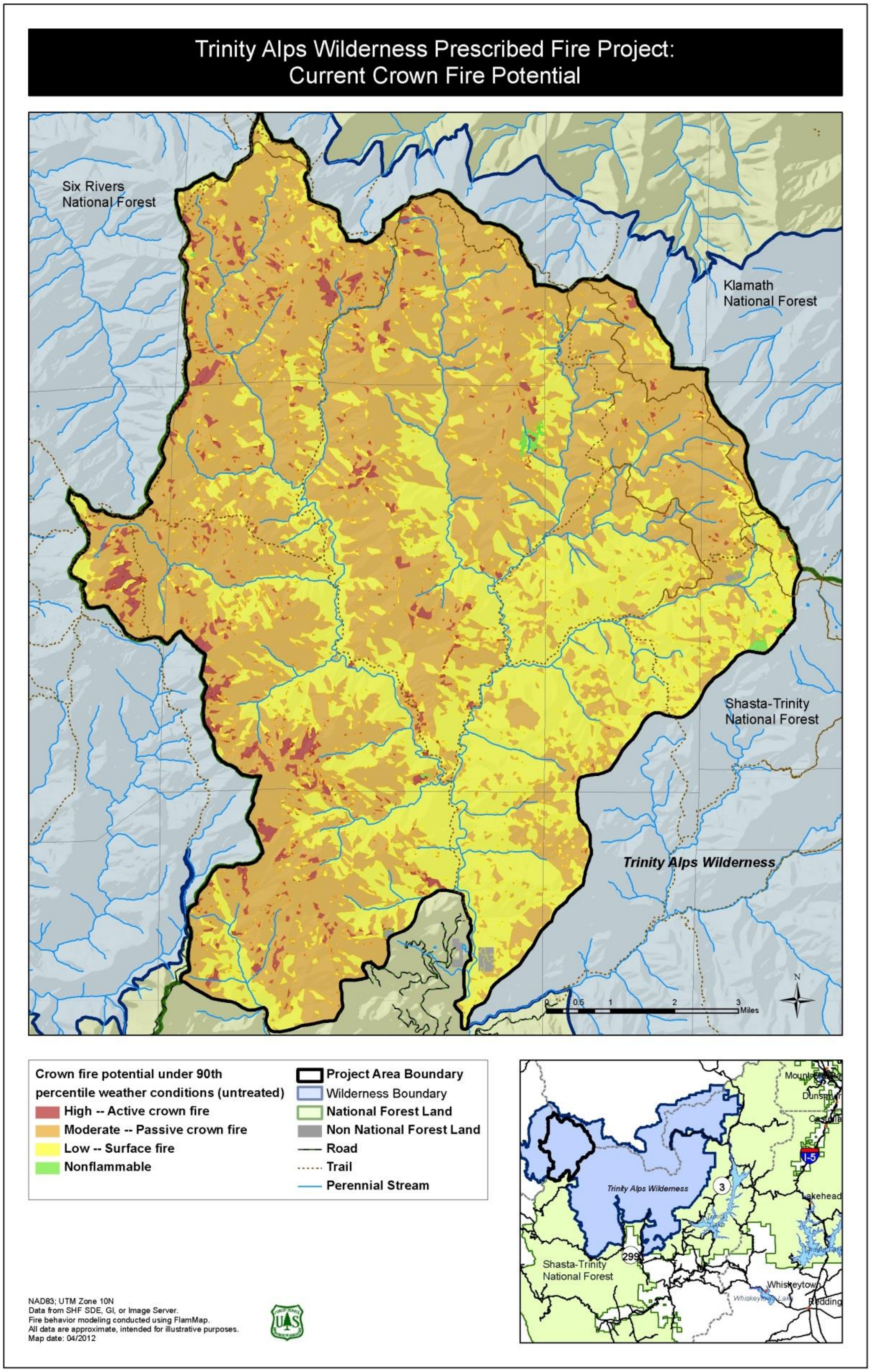
Map 5. Vegetation fire severities during the 2009 Backbone Fire, Trinity Alps Wilderness



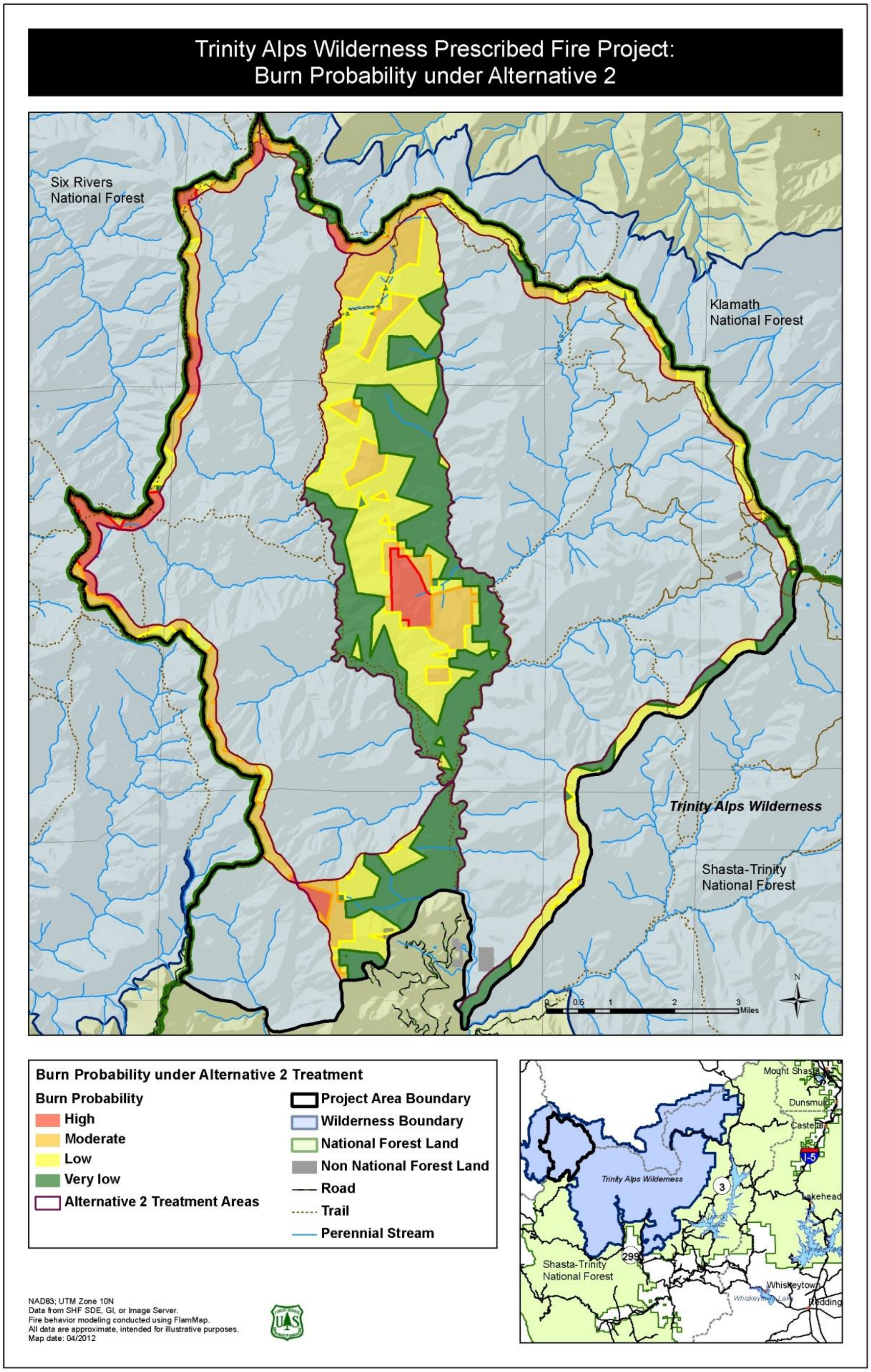
Map 6. Current burn probabilities under 90th percentile conditions in the project area



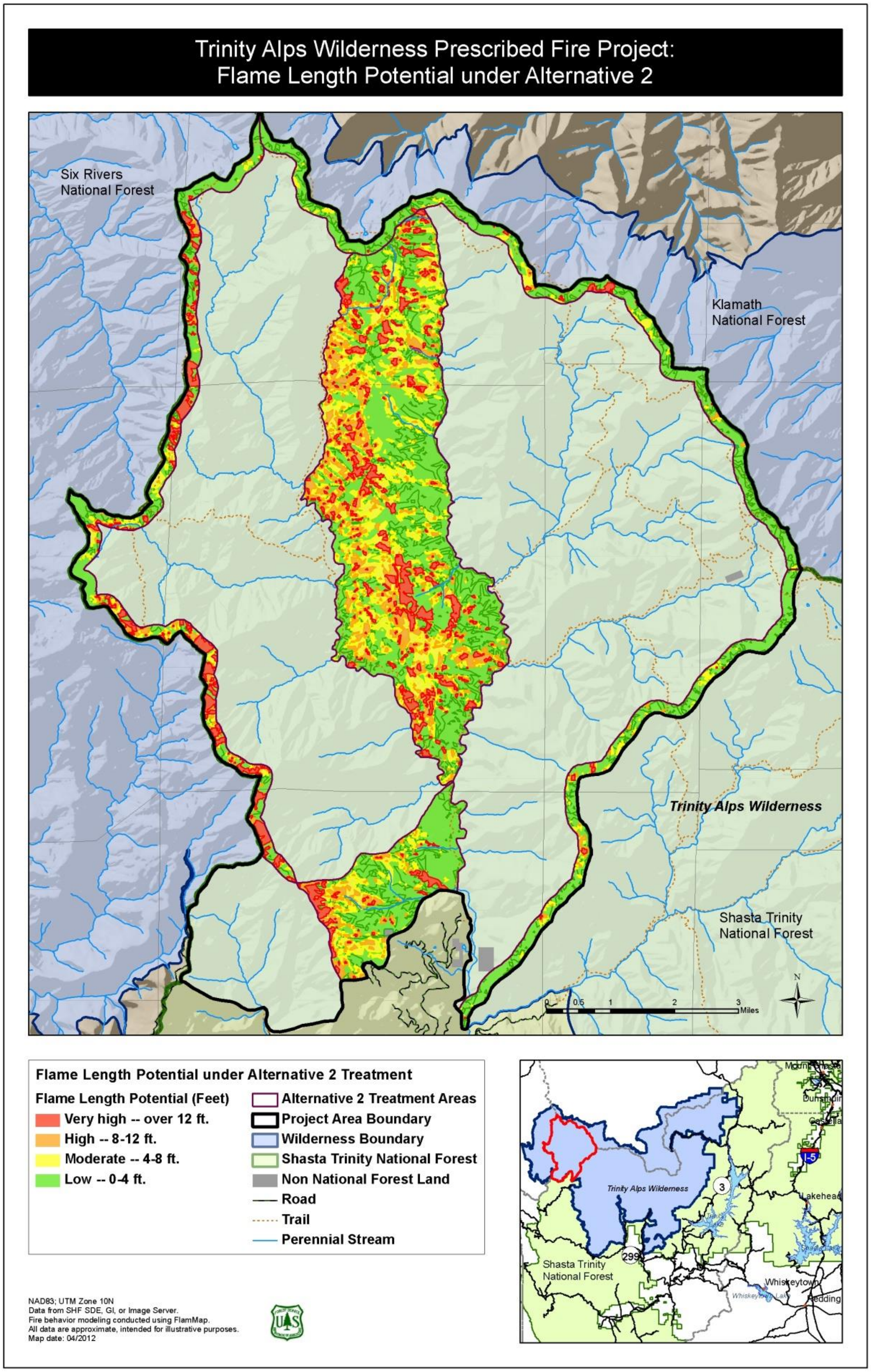
Map 7. Current flame length potential under 90th percentile conditions in the project area



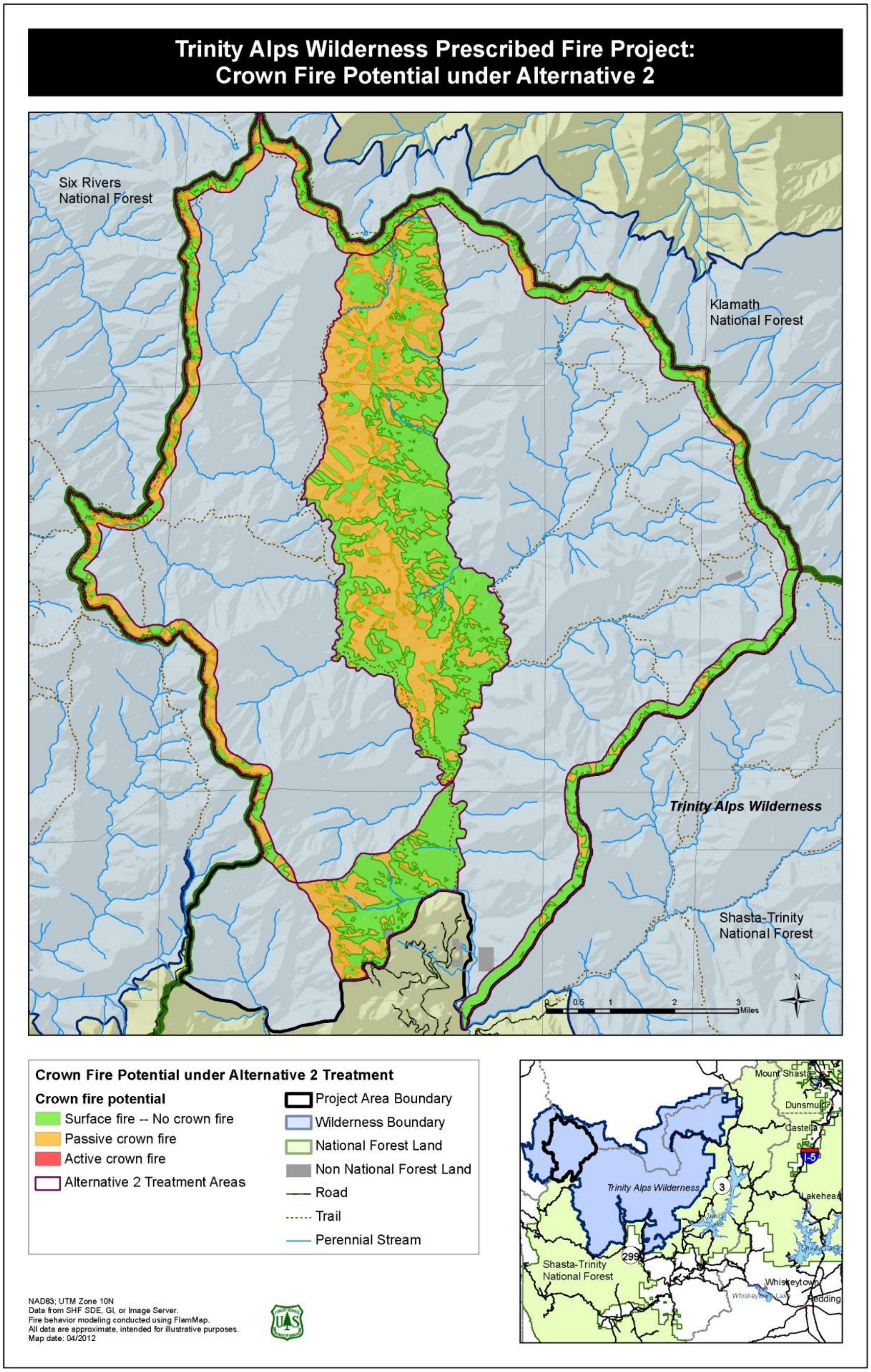
Map 8. Current crown fire potential under 90th percentile conditions in the project area



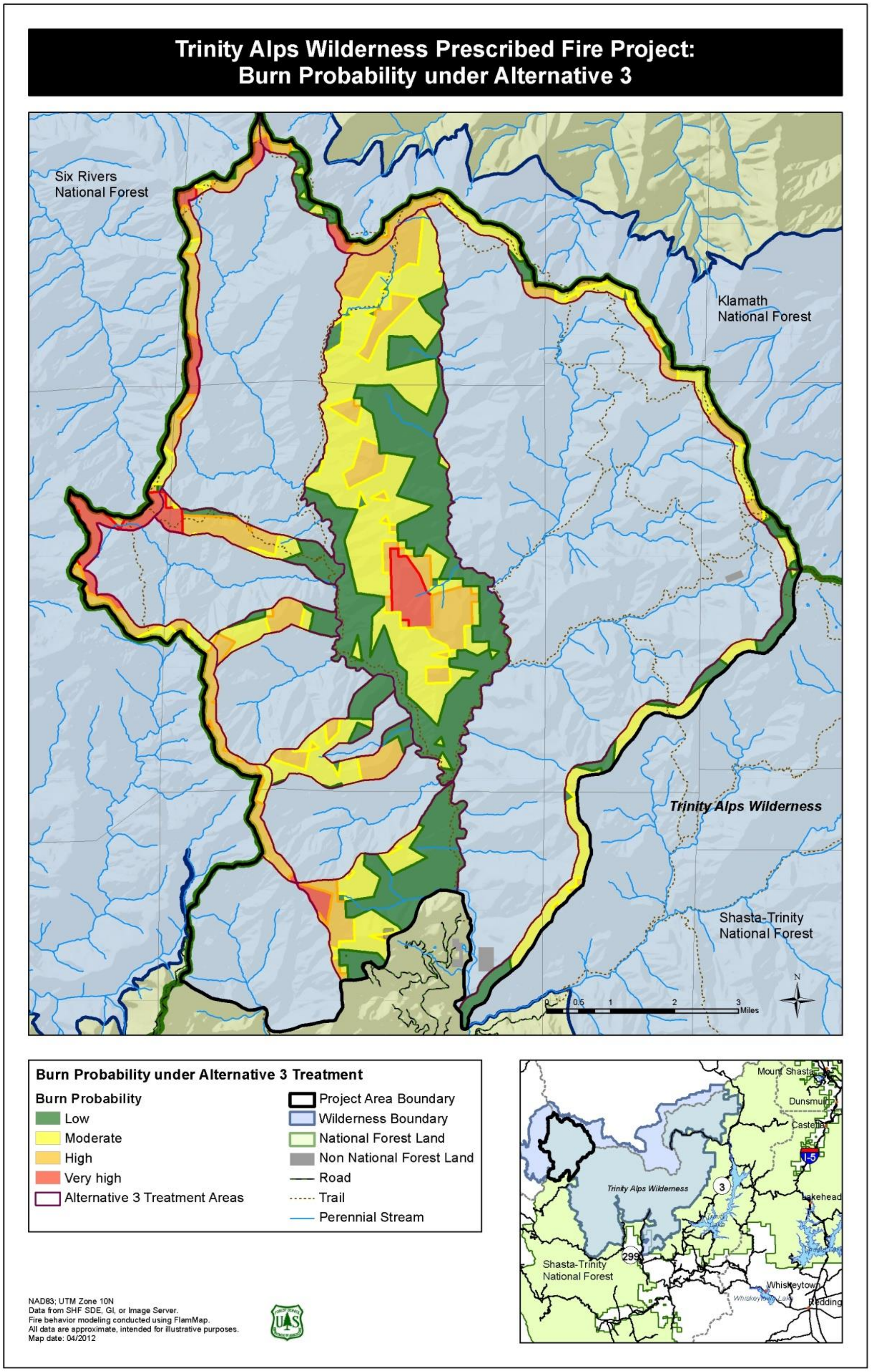
Map 9. Burn probabilities under Alternative 2



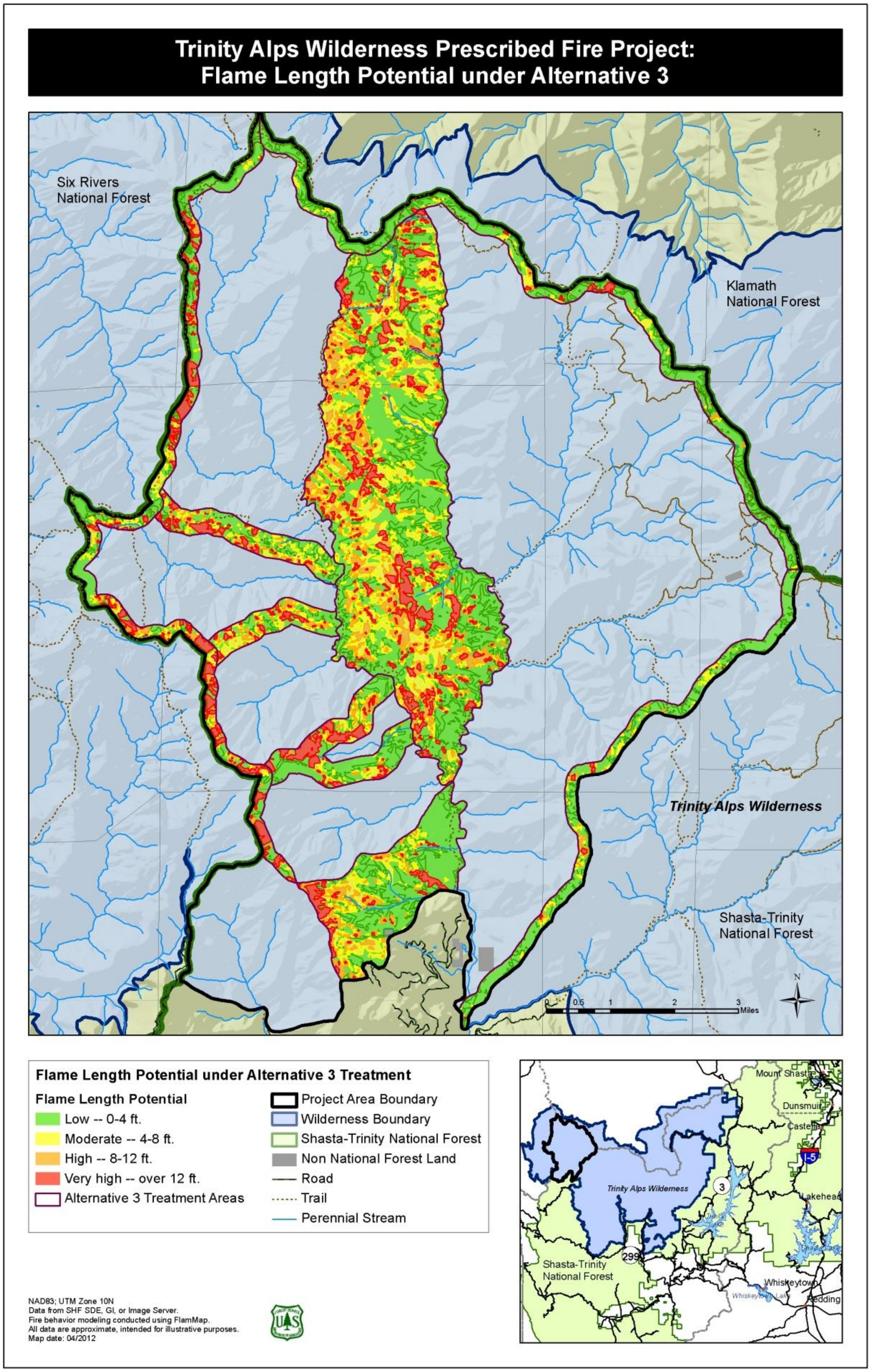
Map 10. Flame length potential under Alternative 2



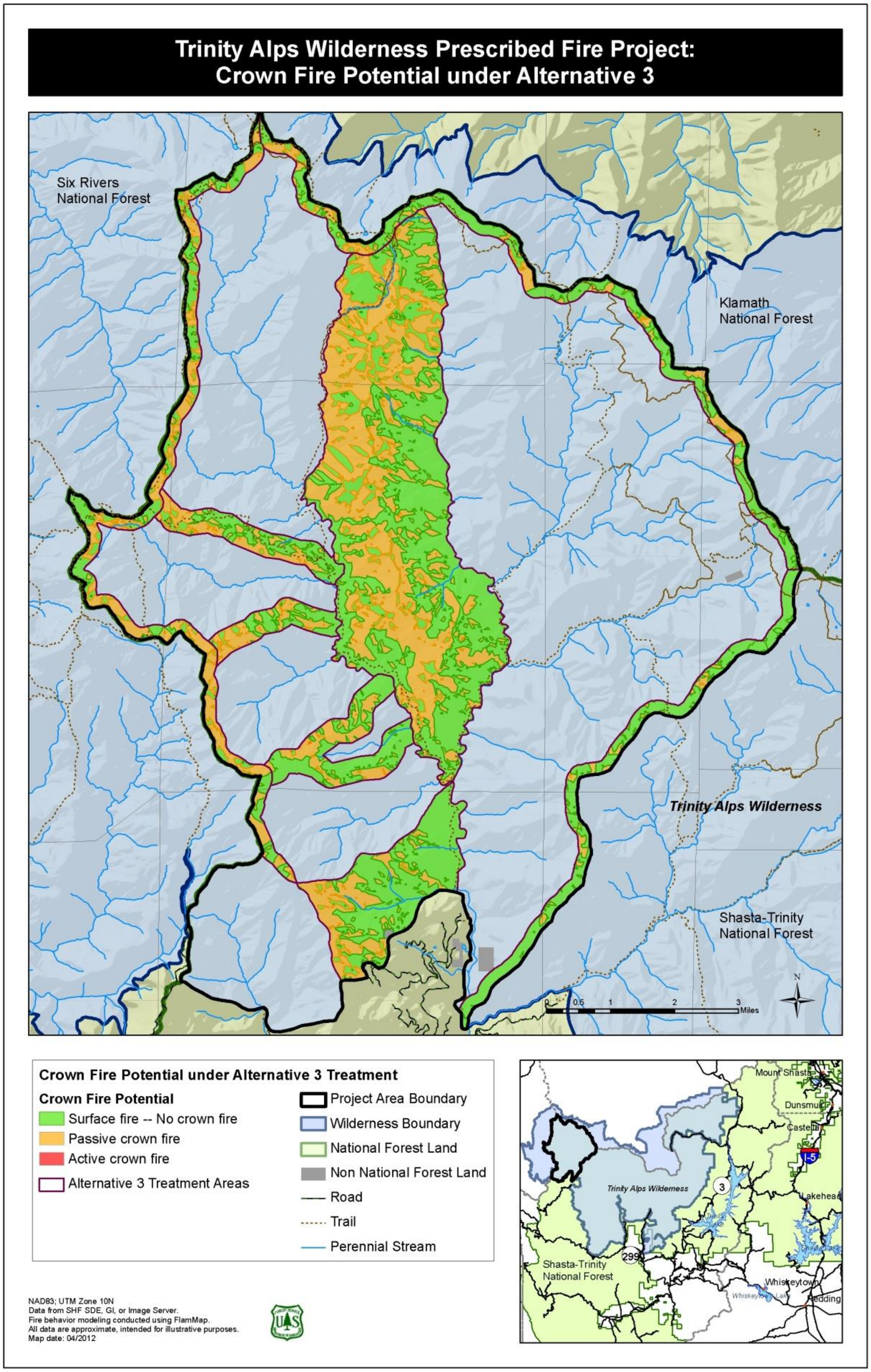
Map 11. Crown fire potential under Alternative 2



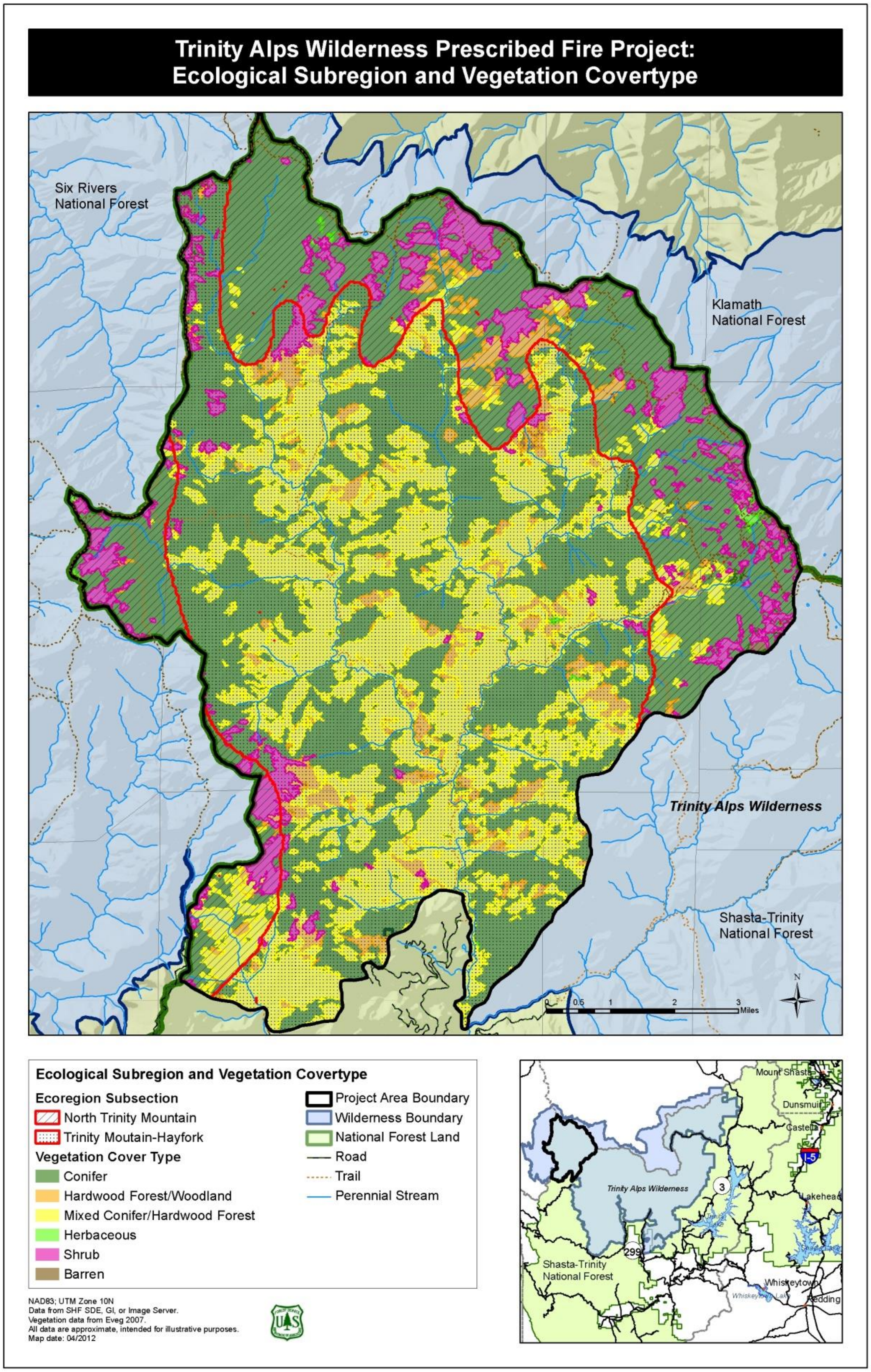
Map 12. Burn probabilities under Alternative 3



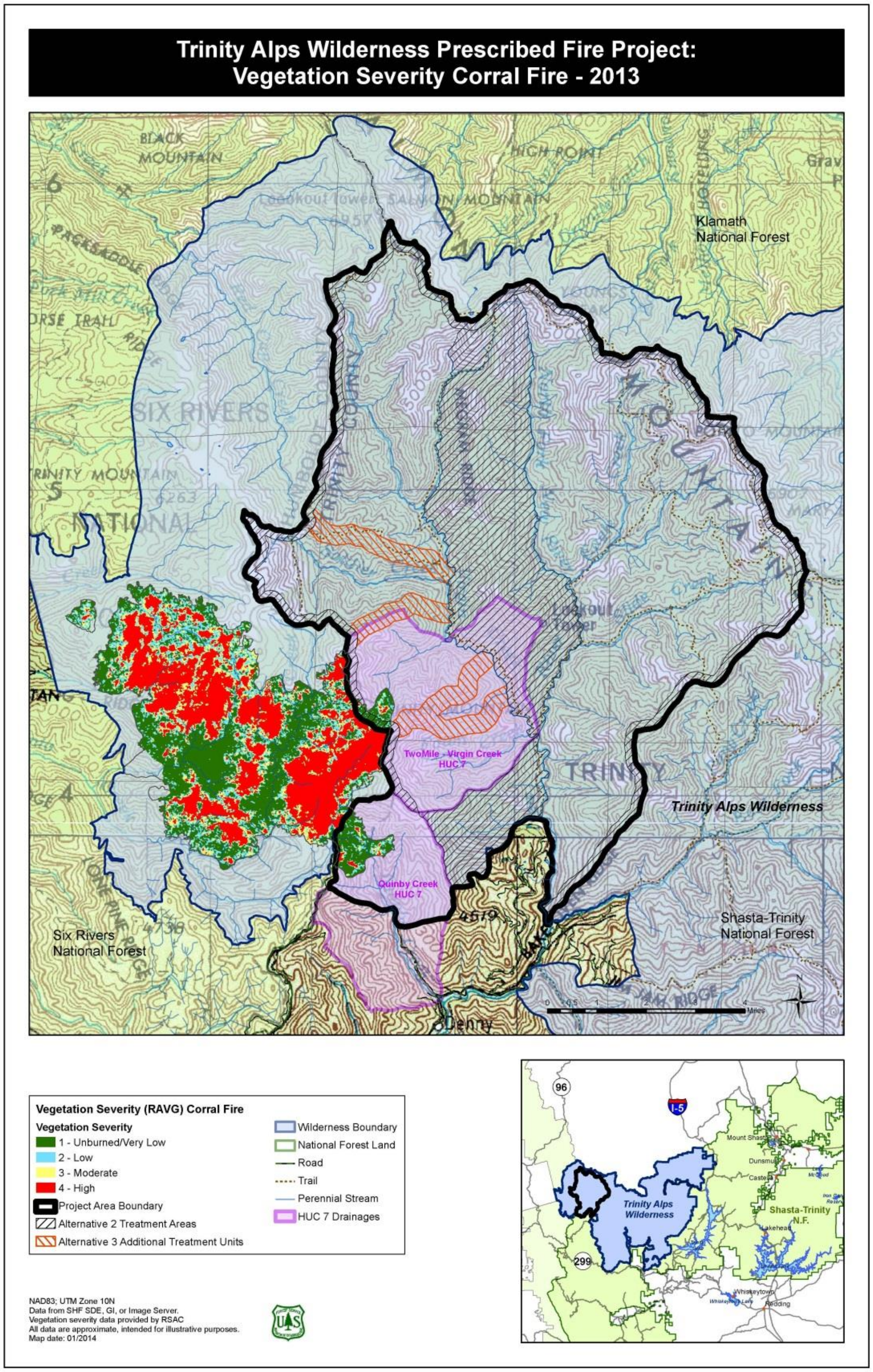
Map 13. Flame length potential under Alternative 3



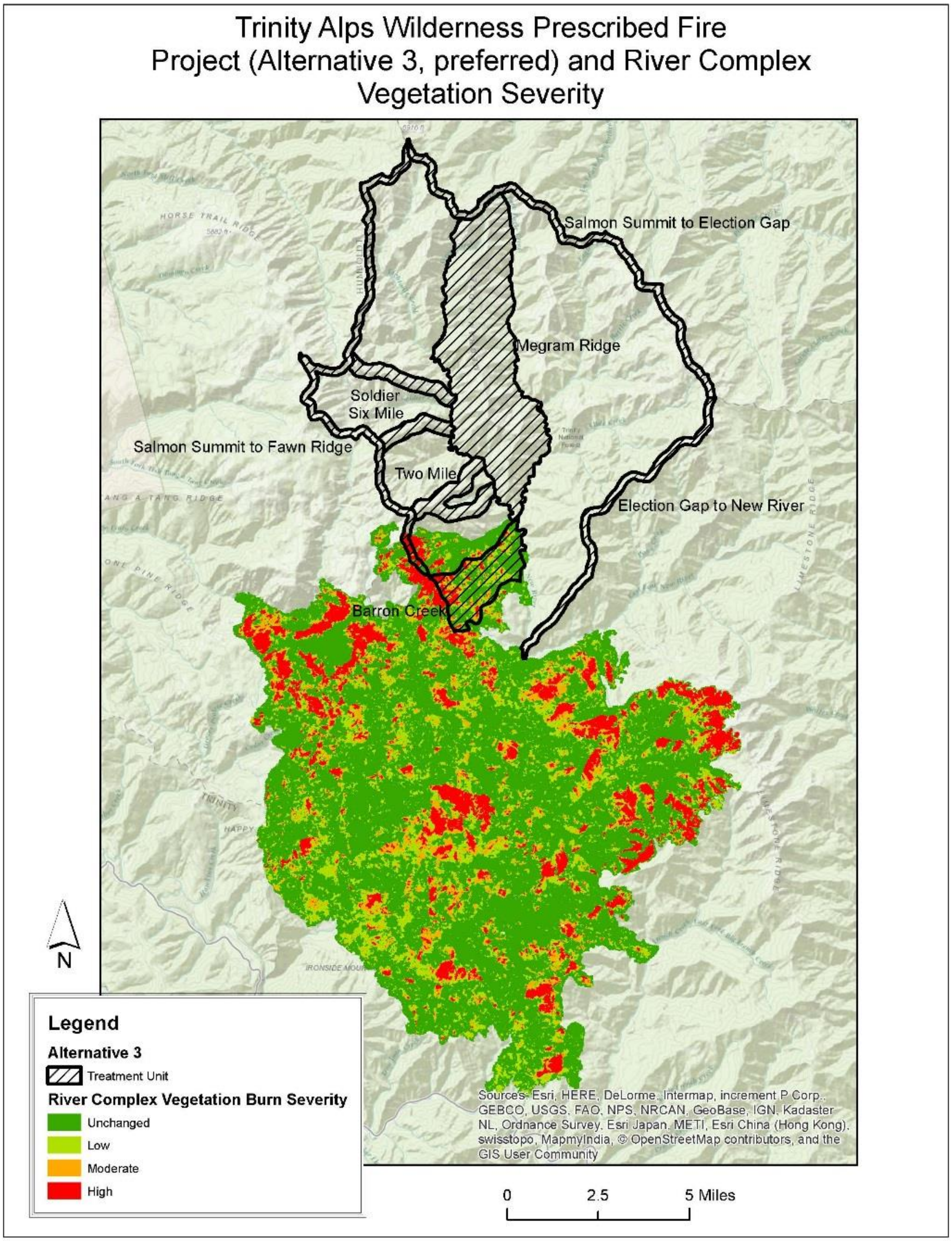
Map 14. Crown fire potential under Alternative 3



Map 15. Ecological Subregions in the project area



Map 16. Ecological Subregions in the project area



Map 17. River Complex 2015 vegetation severity

Appendix C- Ambient Air Quality Standards

Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards [1] Concentration [3]	California Standards [1] Method [4]	National Standards [2] Primary [3,5]	National Standards [2] Secondary [3,6]	National Standards [2] Method [7]
Ozone (O_3)[8]	1 Hour	0.09 ppm (180 µg/m^3)	Ultraviolet Photometry	—	Same as Primary Standard	Ultraviolet Photometry
	8 Hour	0.070 ppm (137 µg/m^3)		0.070 ppm (137 µg/m^3)		
Respirable Particulate Matter (PM10)[9]	24 Hour	50 µg/m^3	Gravimetric or Beta Attenuation	150 µg/m^3	Same as Primary Standard	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	20 µg/m^3		—		
Fine Particulate Matter (PM2.5)[9]	24 Hour	—	—	35 µg/m^3	Same as Primary Standard	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	12 µg/m^3	Gravimetric or Beta Attenuation	12.0 µg/m^3	15 µg/m^3	
Carbon Monoxide (CO)	1 Hour	20 ppm (23 mg/m^3)	Non-Dispersive Infrared Photometry (NDIR)	35 ppm (40 mg/m^3)	—	Non-Dispersive Infrared Photometry (NDIR)
	8 Hour	9.0 ppm (10 mg/m^3)		9 ppm (10 mg/m^3)	—	
	8 Hour (Lake Tahoe)	6 ppm (7 mg/m^3)		—	—	
Nitrogen Dioxide (NO_2)[10]	1 Hour	0.18 ppm (339 µg/m^3)	Gas Phase Chemiluminescence	100 ppb (188 µg/m^3)	—	Gas Phase Chemiluminescence
	Annual Arithmetic Mean	0.030 ppm (57 µg/m^3)		0.053 ppm (100 µg/m^3)	Same as Primary Standard	
Sulfur Dioxide (SO_2)[11]	1 Hour	0.25 ppm (655 µg/m^3)	Ultraviolet Fluorescence	75 ppb (196 µg/m^3)	—	Ultraviolet Flourescence; Spectrophotometry (Pararosaniline Method)
	3 Hour	—		—	0.5 ppm (1300 µg/m^3)	
	24 Hour	0.04 ppm (105 µg/m^3)		0.14 ppm (for certain areas)[11]	—	
	Annual Arithmetic Mean	—		0.030 ppm (for certain areas)[11]	—	
Lead[12,13]	30 Day Average	1.5 µg/m^3	Atomic Absorption	—	—	High Volume Sampler and Atomic Absorption
	Calendar Quarter	—		1.5 µg/m^3 (for certain areas)[12]	Same as Primary Standard	
	Rolling 3-Month Average	—		0.15 µg/m^3		
Visibility Reducing Particles[14]	8 Hour	See footnote 14	Beta Attenuation and Transmittance through Filter Tape	**No National Standards**		
Sulfates	24 Hour	25 µg/m^3	Ion Chromatography			
Hydrogen Sulfide	1 Hour	0.03 ppm (42 µg/m^3)	Ultraviolet Fluorescence			
Vinyl Chloride[12]	24 Hour	0.01 ppm (26 µg/m^3)	Gas Chromatography			

See footnotes on next page …

For more information please call ARB-PIO at (916) 322-2990 — California Air Resources Board (5/4/16)

1. California standards for ozone, carbon monoxide (except 8-hour Lake Tahoe), sulfur dioxide (1 and 24 hour), nitrogen dioxide, and particulate matter (PM10, PM2.5, and visibility reducing particles), are values that are not to be exceeded. All others are not to be equaled or exceeded. California ambient air quality standards are listed in the Table of Standards in Section 70200 of Title 17 of the California Code of Regulations.

2. National standards (other than ozone, particulate matter, and those based on annual arithmetic mean) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest 8-hour concentration measured at each site in a year, averaged over three years, is equal to or less than the standard. For PM10, the 24 hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 $\mu g/m^3$ is equal to or less than one. For PM2.5, the 24 hour standard is attained when 98 percent of the daily concentrations, averaged over three years, are equal to or less than the standard. Contact the U.S. EPA for further clarification and current national policies.

3. Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 torr. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas.

4. Any equivalent measurement method which can be shown to the satisfaction of the ARB to give equivalent results at or near the level of the air quality standard may be used.

5. National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.

6. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

7. Reference method as described by the U.S. EPA. An "equivalent method" of measurement may be used but must have a "consistent relationship to the reference method" and must be approved by the U.S. EPA.

8. On October 1, 2015, the national 8-hour ozone primary and secondary standards were lowered from 0.075 to 0.070 ppm.

9. On December 14, 2012, the national annual PM2.5 primary standard was lowered from 15 $\mu g/m^3$ to 12.0 $\mu g/m^3$. The existing national 24-hour PM2.5 standards (primary and secondary) were retained at 35 $\mu g/m^3$, as was the annual secondary standard of 15 $\mu g/m^3$. The existing 24-hour PM10 standards (primary and secondary) of 150 $\mu g/m^3$ also were retained. The form of the annual primary and secondary standards is the annual mean, averaged over 3 years.

10. To attain the 1-hour national standard, the 3-year average of the annual 98th percentile of the 1-hour daily maximum concentrations at each site must not exceed 100 ppb. Note that the national 1-hour standard is in units of parts per billion (ppb). California standards are in units of parts per million (ppm). To directly compare the national 1-hour standard to the California standards the units can be converted from ppb to ppm. In this case, the national standard of 100 ppb is identical to 0.100 ppm.

11. On June 2, 2010, a new 1-hour SO_2 standard was established and the existing 24-hour and annual primary standards were revoked. To attain the 1-hour national standard, the 3-year average of the annual 99th percentile of the 1-hour daily maximum concentrations at each site must not exceed 75 ppb. The 1971 SO_2 national standards (24-hour and annual) remain in effect until one year after an area is designated for the 2010 standard, except that in areas designated nonattainment for the 1971 standards, the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved.

    Note that the 1-hour national standard is in units of parts per billion (ppb). California standards are in units of parts per million (ppm). To directly compare the 1-hour national standard to the California standard the units can be converted to ppm. In this case, the national standard of 75 ppb is identical to 0.075 ppm.

12. The ARB has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

13. The national standard for lead was revised on October 15, 2008 to a rolling 3-month average. The 1978 lead standard (1.5 $\mu g/m^3$ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

14. In 1989, the ARB converted both the general statewide 10-mile visibility standard and the Lake Tahoe 30-mile visibility standard to instrumental equivalents, which are "extinction of 0.23 per kilometer" and "extinction of 0.07 per kilometer" for the statewide and Lake Tahoe Air Basin standards, respectively.

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